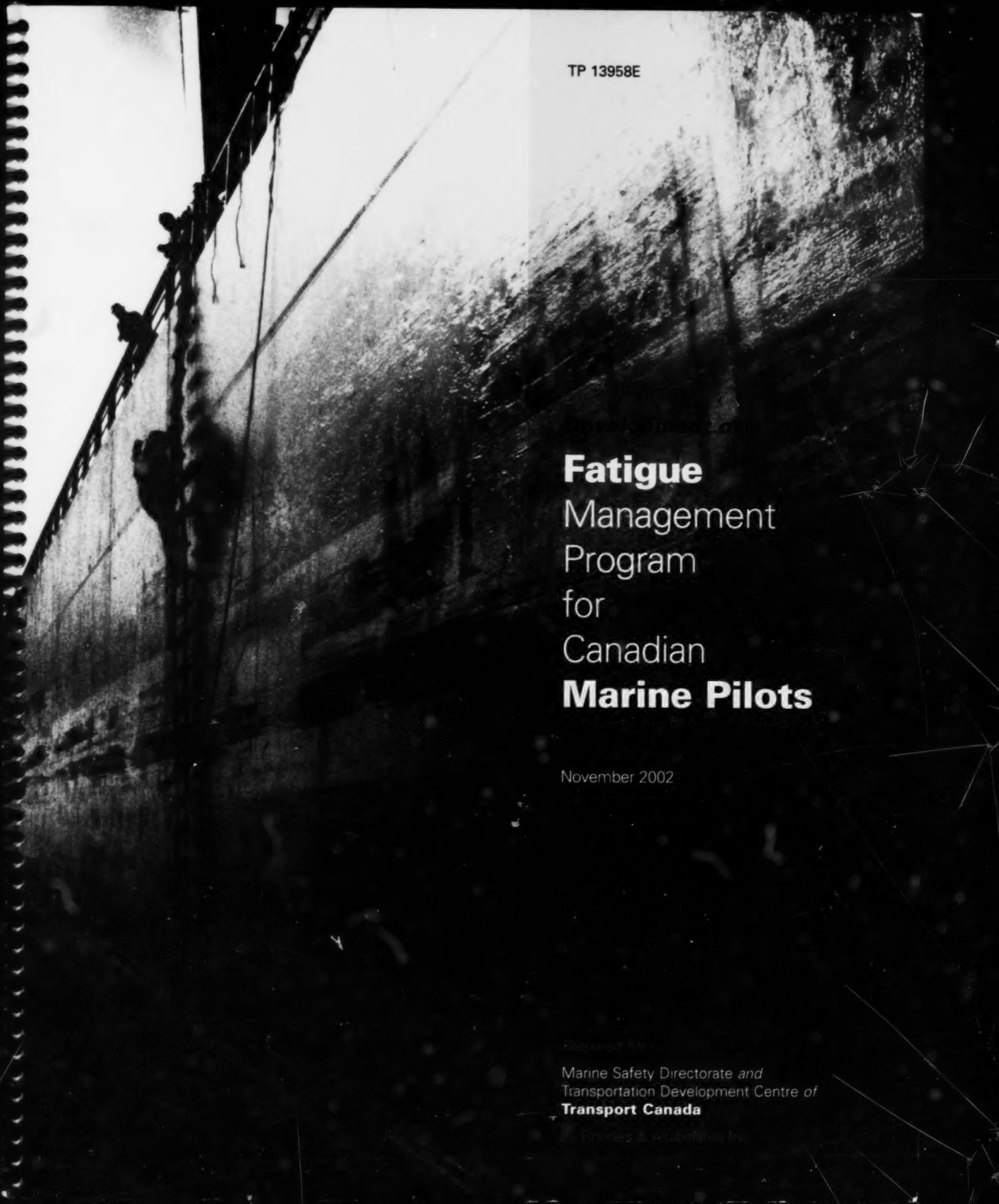

TP 13958E

Fatigue Management Program for Canadian **Marine Pilots**

November 2002

Prepared for:

Marine Safety Directorate *and*
Transportation Development Centre *of*
Transport Canada

by Rhodes & Associates Inc.

103-06225/

TP 13958E

Development of a Fatigue Management Program for Canadian Marine Pilots

Prepared by
Wayne Rhodes, Ph.D., C.P.E.
Valérie Gil, Ph.D.

November 2002

This report reflects the views of the authors and not necessarily those of the Transportation Development Centre or the Marine Safety Directorate of Transport Canada.

Un sommaire français se trouve avant la table des matières.

Illustrations by Ben Hodson, © Wayne Rhodes, 2001

Desktop publishing by Transportation Development Centre, Transport Canada

Cover photo courtesy of the Pacific Pilotage Authority Canada.

Transport Canada Transports Canada

PUBLICATION DATA FORM

1. Transport Canada Publication No.
TP 13958E

2. Project No.
9991-2

3. Recipient's Catalogue No.

4. Title and Subtitle
Development of a Fatigue Management Program
for Canadian Marine Pilots

5. Publication Date
November 2002

6. Performing Organization Document No.

7. Author(s)
Wayne Rhodes and Valérie Gil

8. Transport Canada File No.
ZCD2450-CP411

9. Performing Organization Name and Address
Rhodes & Associates Inc.
177 Jenny Wrenway
Toronto, ON
M2H 2Z3

10. PWGSC File No.
MTB-0-01474

11. PWGSC or Transport Canada Contract No.
T8200-0-0533/001/MTB

12. Sponsoring Agency Name and Address
Transportation Development Centre (TDC)
800 René Lévesque Blvd. West
Suite 600
Montreal, Quebec
H3B 1X9

13. Type of Publication and Period Covered
Final

14. Project Officer
J.D. Reid

15. Supplementary Notes (Funding programs, titles of related publications, etc.)
TP 13959E Fatigue Management Guide for Canadian Marine Pilots
TP 13960E Fatigue Management Guide for Canadian Marine Pilots: A Trainers' Handbook

16. Abstract

The goal of this project was to investigate fatigue issues in marine pilotage (Phase 1) and develop a fatigue management program (FMP) prototype (Phase 2). The research involved preparing an extensive literature review of fatigue and fatigue countermeasures in the marine environment; conducting a study of Canadian marine pilotage fatigue issues through the collection of data using a questionnaire, on-board observations, and interviews; and developing an FMP prototype including training components, implementation plan, and guidelines for scheduling pilots, and monitoring and evaluating the FMP. The study indicated that schedules and peak workloads experienced by Canadian marine pilots produced a potential for significant levels of fatigue, and that an FMP is clearly needed. In addition to this report, the research produced two other publications intended to be used in fatigue management workshops for marine pilots: *Fatigue Management Guide for Canadian Marine Pilots* (TP 13959E), and *Fatigue Management Guide for Canadian Marine Pilots: A Trainer's Handbook* (TP 13960E).

17. Key Words
FMP, fatigue, marine pilots, management program, scheduling, research report

18. Distribution Statement
Limited number of copies available from the Transportation Development Centre

19. Security Classification (of this publication)
Unclassified

20. Security Classification (of this page)
Unclassified

21. Declassification (date)
—

22. No. of Pages
xxii, 90, apps

23. Price
Shipping/ Handling

Transports Canada Transport Canada

FORMULE DE DONNÉES POUR PUBLICATION

1. N° de la publication de Transports Canada
TP 13958E

2. N° de l'étude
9991-2

3. N° de catalogue du destinataire

4. Titre et sous-titre
Development of a Fatigue Management Program
for Canadian Marine Pilots

5. Date de la publication
Novembre 2002

6. N° de document de l'organisme exécutant

7. Auteur(s)
Wayne Rhodes et Valérie Gil

8. N° de dossier - Transports Canada
ZCD2450-CP411

9. Nom et adresse de l'organisme exécutant
Rhodes & Associates Inc.
177 Jenny Wrenway
Toronto, ON
M2H 2Z3

10. N° de dossier - TPSGC
MTB-1-01474

11. N° de contrat - TPSGC ou Transports Canada
T8200-0-0533/001/MTB

12. Nom et adresse de l'organisme parrain
Centre de développement des transports (CDT)
800, boul. René-Lévesque Ouest
Bureau 600
Montréal (Québec)
H3B 1X9

13. Genre de publication et période visée
Final

14. Agent de projet
J.D. Reid

15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.)
TP 13959F Guide de gestion de la fatigue pour les pilotes maritimes canadiens
TP 13960F Guide de gestion de la fatigue pour les pilotes maritimes canadiens : manuel du formateur

16. Résumé

Ce projet avait pour objectifs d'étudier la question de la fatigue dans le pilotage maritime (phase 1) et d'élaborer un prototype de programme de gestion de la fatigue (PGF) (phase 2). Les travaux ont comporté une recherche documentaire poussée sur la fatigue et les contre-mesures à la fatigue dans le secteur maritime; une étude sur le problème de la fatigue dans le secteur canadien du pilotage maritime, à partir des données colligées au moyen d'un questionnaire, d'observations faites à bord des navires et d'entrevues; et l'élaboration d'un prototype de PGF comprenant des outils de formation, un plan de mise en œuvre du programme et des lignes directrices pour l'établissement des horaires des pilotes et pour le suivi et l'évaluation du programme. L'étude a révélé que les horaires des pilotes maritimes canadiens et leur charge de travail en période de pointe peuvent, de fait, engendrer un degré élevé de fatigue, et qu'un PGF s'impose nettement. Outre le présent rapport, la recherche a donné lieu à deux autres publications spécialement conçues pour les ateliers de gestion de la fatigue destinés aux pilotes maritimes. Ce sont le *Guide de gestion de la fatigue pour les pilotes maritimes canadiens* (TP 13959F) et le *Guide de gestion de la fatigue pour les pilotes maritimes canadiens : manuel du formateur* (TP 13960F).

17. Mots clés
PGF, fatigue, pilotes maritimes, programme de gestion, horaire, rapport de recherche

18. Diffusion
Le Centre de développement des transports dispose d'un nombre limité d'exemplaires.

19. Classification de sécurité (de cette publication)	20. Classification de sécurité (de cette page)	21. Déclassification (date)	22. Nombre de pages	23. Prix
Non classifiée	Non classifiée	—	xxii, 90, ann.	Port et manutention

Canada

Preface

This report is part of a three-document set for the development of a fatigue management program for Transport Canada by Rhodes & Associates Inc. The three documents are:

1. *Development of a Fatigue Management Program for Canadian Marine Pilots* – TP 13958E.
2. *Fatigue Management Guide for Canadian Marine Pilots* – TP 13959E
3. *Fatigue Management Guide for Canadian Marine Pilots: A Trainer's Handbook* – TP 13960E

The development of the program involved two phases:

Phase 1	Research into fatigue issues in marine pilotage
Phase 2	Development of a fatigue management program (FMP)

The program consists of three components:

i. FMP implementation plan
ii. FMP training module
iii. FMP guidelines for scheduling pilots and for monitoring and evaluating the FMP

This report contains findings from the initial literature review and study of fatigue issues in marine pilotage; the fatigue management program plan; and the FMP guidelines for scheduling pilots, and monitoring and evaluating the FMP.

Acknowledgements

This guide was developed with the support of the Great Lakes Pilotage Authority and Transport Canada's Marine Safety Directorate, in conjunction with the Transportation Development Centre. A steering committee consisting of members from these organizations and others from the marine industry and pilotages reviewed and contributed to the guide. The following is a list of these representatives:

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Dr. Carlos Comperatore, Researcher, U.S. Coast Guard, R&D Center
Leonard Kingsley, Project Manager, U.S. Coast Guard, R&D Center

The authors would also like to thank the scientists who reviewed the work and helped us in the review of this research. We are grateful to:

Dr. Victor Ujimoto, Guelph University
Dr. Tony Parker, Queensland University of Technology
Dr. Diane Boivin, McGill University
Dr. Ron Heslegrave, University of Toronto

Lastly, we are very grateful for the dedication and patience of the pilots who helped us to understand their job and the nature of their work environment. We thank them for allowing us to accompany them during their assignments and for providing us with their practical insights and wisdom.

Wayne Rhodes, Ph.D., C.P.E.
Valérie Gil, Ph.D.

Executive Summary

This report is part of a three-document set for the development of a fatigue management program for Transport Canada by Rhodes & Associates Inc. The three documents are:

1. *Development of a Fatigue Management Program for Canadian Marine Pilots* – TP 13958E
2. *Fatigue Management Guide for Canadian Marine Pilots* – TP 13959E
3. *Fatigue Management Guide for Canadian Marine Pilots: A Trainer's Handbook* – TP 13960E

The report includes the findings of the literature review, a survey of fatigue in marine pilotage, a plan for implementation of a fatigue management program, and guidelines for scheduling pilots, and program monitoring and evaluation. Training components consist of the fatigue management guide for the pilots (TP 13959E), a handbook for trainers (TP 13960E) and a slide set in MS PowerPoint for presenting the material.

The project was conducted on behalf of Transport Canada's Marine Safety Directorate and the Transportation Development Centre (TDC) of Transport Canada, the Canadian pilotage authorities, Canadian ship owners and Canadian marine pilots.

Findings from the Literature Review

Several incident reports from the Canadian Transportation Safety Board state that fatigue was a factor in incidents involving ships while under the guidance of marine pilots. One of these reports recommends that the pilotages and Transport Canada pursue research on marine pilot fatigue and develop a means to reduce fatigue in marine pilots. Research on fatigue in marine operations and specifically marine pilotage provide several lines of evidence that pilot fatigue is a major concern. A number of fatigue management programs are identified and reviewed. The best elements of these programs are identified, for integration into a fatigue management program for marine pilotage.

Reporting of Marine Pilotage Fatigue Issues

A survey of Canadian marine pilots was conducted to identify the potential for fatigue and the tasks that are likely affected. Observations and interviews were conducted, and a survey was distributed to pilots within the Great Lakes Pilotage Authority (GLPA), which agreed to participate. These data collection tools are found in Appendix A of this report.

The research findings are organized as follows:

- hours of work;
- fatigue;
- sleep; and
- coping strategies.

Hours of Work

Marine pilots work irregular hours that sometimes include long assignments with minimal time off in between. Although they typically get more than 14 hours off between assignments, the opportunity to take more assignments during busy periods often results in shorter periods of rest and longer periods of work. Assignments are usually about 8 to 9 hours long, but can be longer in poor weather during the busy seasons. Long waits for ships to arrive or times waiting for ships to clear locks can extend assignment lengths by several hours. These hours of work occur during all times of day, with almost 50% of the assignments occurring at night. This means that half of the sleep during a pilot's tour de role (name of the prioritized assignment system) will be during the daytime. Daytime sleep results in poorer sleep that is often about one and a half to two hours less than sleep on days off.

Fatigue

The irregular hours and shortened sleep periods result in building fatigue from an accumulating sleep debt during the tour de role. After the usual number of assignments, pilots may become sleep deprived. However, during the busy periods, they can be severely sleep deprived. They report that the fatigue does make vigilance and staying awake during the early morning hours difficult. Most asserted that they push their way through until they complete the assignment, then later they allow themselves to succumb to the fatigue. Many of the pilots take advantage of a taxi service that allows them to get home without having to drive. Pilots who do drive have indicated that the drive home is very difficult after night assignments. Of those who do drive (n=22), all have reported nodding off at least once. One individual reported that he had gone off the road, having fallen asleep at the wheel after working a night assignment.

Sleep

Marine pilots average just less than 8 hours of sleep on days off, a little over 7 hours of sleep during the night after daytime assignments and only 6.5 hours of sleep during the day following night assignments. This translates into about 1.5 hours of sleep lost, on average, per nighttime assignment. During busy periods fatigue mounts up quickly as pilots swing back and forth between night and day assignments, with minimal time off, starting at different times each day. Weather and traffic conditions can exacerbate this situation, increasing stress and fatigue. Despite the fact that marine pilots claim that these levels of fatigue can be handled, it is clear from the literature that sleep loss over a number of consecutive work periods with minimal time off between (e.g. less than 12 hours) can lead to serious sleep debts. Sleep debts of only 6 to 8 hours per work cycle can lead to significant performance decrements and, combined with night work and long hours, can seriously affect memory function, information processing and vigilance.

Coping Strategies

Almost all pilots use caffeine and a nap prior to going on an assignment. This is consistent with findings showings that individuals can perform almost as well during night shifts as they do on day shifts if they are well rested prior to the assignment and use a single caffeine drink (Horne & Reyner, 1996). This strategy is effective in helping even fatigued individuals to maintain better performance than otherwise would have been the case.

Many pilots are aware of the importance of obtaining restful sleep and have installed room darkening blinds, fans and air conditioning. However, additional strategies to improve sleep, such as those involving dietary intake, relaxation techniques and prior knowledge of the effects of various substances are not as well known and would be helpful.

Recommendations Based on the Research

The following recommendations were made based on the research:

- reduce waiting time and scheduling uncertainty that causes fatigue and stress;
- reduce the number of long duration assignments and/or their impact on fatigue;
- decrease fatigue during night work by reducing assignment length, limiting number of consecutive nights, allowing planned napping and increasing the rest periods between;
- reduce the impact of short calls on fatigue by assigning them immediately after days off and prohibiting the occurrence of consecutive short calls; and
- improve rest between and during assignments by helping pilots develop effective strategies for sleep at home and during planned nap periods, and by installing improved facilities for sleeping at locks and pilot houses.

Description of a Fatigue Management (FMP) Prototype

The fatigue management program includes the following components:

- sleep and fatigue awareness training for management and pilots;
- proposed guidelines for scheduling assignments;
- guidelines for FMP implementation (support resources, process, responsibilities, etc.); and
- an FMP evaluation process.

Purpose of the Fatigue Management (FM) Guidelines

The FM guidelines provide information and instruction for **scheduling and FMP monitoring and evaluation**. The scheduling guidelines are to be used in conjunction with standard scheduling procedures. They are a tool to be used at the discretion of the dispatcher, and within the rules of the collective agreements. The monitoring guidelines provide guidance on maintaining contact with the participants in the FMP process, the dissemination of information on fatigue management and the use of feedback for input to the evaluation process. The evaluation guidelines provide a structure for formally assessing the program at the end of each year of implementation.

Sommaire

Ce rapport fait partie d'une série de trois documents produits au cours de travaux visant l'élaboration d'un programme de gestion de la fatigue réalisés pour Transports Canada par Rhodes & Associates Inc. Ces documents ont pour titres :

1. *Development of a Fatigue Management Program for Canadian Marine Pilots* – TP 13958E
2. *Guide de gestion de la fatigue pour les pilotes maritimes canadiens* – TP 13959F
3. *Guide de gestion de la fatigue pour les pilotes maritimes canadiens : manuel du formateur* – TP 13960F

Ce rapport présente les conclusions de la recherche documentaire et de l'étude sur la fatigue dans le pilotage maritime, un plan pour la mise en œuvre d'un programme de gestion de la fatigue et des lignes directrices pour l'établissement des horaires des pilotes et pour le suivi et l'évaluation du programme. Les outils de formation comprennent le guide de gestion de la fatigue pour les pilotes (TP 13959F) et un manuel pour les formateurs (TP 13960F), de même qu'une série de diapositives MS PowerPoint qui résume la matière.

Le projet a été réalisé pour le compte de la Direction générale de la sécurité maritime de Transports Canada et du Centre de développement des transports (CDT) de Transports Canada, des administrations canadiennes de pilotage, des armateurs canadiens et des pilotes maritimes canadiens.

Conclusions de la recherche documentaire

Plusieurs rapports d'enquête du Bureau de la sécurité des transports du Canada ont conclu que la fatigue a joué un rôle dans des incidents mettant en cause des navires sous la conduite de pilotes maritimes. Un de ces rapports recommande aux administrations de pilotage et à Transports Canada d'approfondir la question de la fatigue chez les pilotes maritimes et de trouver des moyens de réduire la fatigue chez ces travailleurs. La recherche sur la fatigue dans les opérations maritimes, et plus particulièrement dans le pilotage maritime, a apporté la confirmation de plusieurs sources que la fatigue des pilotes constitue un problème majeur. Certains programmes de gestion de la fatigue sont recensés et commentés. Les meilleurs éléments de ces programmes sont retenus en vue de leur intégration à un programme de gestion de la fatigue destiné au secteur du pilotage maritime.

Conclusions de l'étude sur la fatigue dans le secteur du pilotage maritime

Une étude a été faite auprès des pilotes maritimes canadiens, afin d'évaluer le danger que représente la fatigue et de cerner les tâches particulièrement à risque. Cette étude a pris la forme d'observations, d'entrevues et d'un questionnaire distribué aux pilotes de l'Administration de pilotage des Grands Lacs (APGL) qui avaient accepté de participer à l'étude. Ces outils de collecte de données sont joints en annexe A du rapport.

Les résultats de l'étude sont réunis sous les rubriques suivantes :

- heures de travail;
- fatigue;
- sommeil;
- stratégies pour lutter contre la fatigue.

Heures de travail

Les pilotes maritimes ont des horaires de travail irréguliers, qui comprennent parfois plusieurs longues affectations de suite, séparées par de courtes périodes de repos. Même si, en principe, ils ont droit à plus de 14 heures de repos entre deux affectations, la possibilité qu'ils ont d'accepter des affectations supplémentaires en période de pointe a souvent pour effet de réduire leurs heures de repos et d'augmenter d'autant leurs heures de service. Les affectations ont habituellement une durée de 8 à 9 heures, mais elles peuvent être plus longues par mauvais temps, en saison de fort trafic. Les longues heures d'attente avant l'arrivée du navire ou pendant qu'il traverse une écluse peuvent allonger une affectation de plusieurs heures. Ces affectations couvrent toutes les périodes du jour et près de la moitié ont lieu la nuit. Cela signifie que le pilote de tour de rôle (c'est ainsi que l'on désigne le système d'affectation selon un ordre de priorité) dort le jour la moitié du temps. Or, dormir le jour équivaut à moins bien dormir et à dormir moins, car chez beaucoup de pilotes, le sommeil de jour est raccourci d'une heure et demie à deux heures par rapport au sommeil qu'ils obtiennent lorsqu'ils sont en congé.

Fatigue

Des heures de travail irrégulières et des périodes de sommeil écourtées mènent à la fatigue, engendrée par l'accumulation d'un déficit de sommeil pendant le tour de rôle. Lorsqu'ils accomplissent le nombre normal d'affectations, les pilotes sont parfois privés de sommeil. Mais durant les périodes de pointe, cette privation peut être grave. Ils déclarent en effet qu'à cause de la fatigue, ils ont du mal à demeurer vigilants, voire à rester éveillés, aux petites heures du matin. La plupart affirment qu'ils tiennent le coup tant bien que mal jusqu'à la fin de leur affectation et qu'ils se permettent alors de succomber à la fatigue. Beaucoup de pilotes préfèrent prendre un taxi pour retourner chez eux, plutôt que de conduire eux-mêmes. Ceux qui utilisent leur véhicule trouvent très difficile de conduire jusque chez eux après une affectation de nuit. Parmi ceux qui utilisent leur véhicule (n=22), tous ont déclaré avoir cogné des clous au moins une fois au volant. Un pilote a déclaré avoir déjà quitté la route alors qu'il s'était endormi au volant après une affectation de nuit.

Sommeil

Les pilotes maritimes dorment, en moyenne, un peu moins de 8 heures pendant leurs jours de congé, un peu plus de 7 heures la nuit qui suit une affectation de jour et seulement 6,5 heures le jour qui suit une affectation de nuit. Cela veut dire qu'ils perdent environ 1,5 heure de sommeil, en moyenne, par affectation de nuit. Pendant les périodes de pointe, la fatigue croît rapidement, car les pilotes vont d'affectations de jour en affectations de nuit et vice versa, ont des périodes de repos de courte durée et ne commencent jamais à la même heure. Des conditions météorologiques défavorables et un trafic intense peuvent se mettre de la partie et accentuer leur stress et leur fatigue. Même si les pilotes prétendent que de tels degrés de fatigue sont acceptables, il ressort nettement de la recherche documentaire que des pertes de sommeil récurrentes, dues à plusieurs périodes de travail consécutives séparées par de courtes périodes de repos (p. ex., moins de 12 heures), peuvent mener à de lourds déficits de sommeil. Or, il suffit d'un déficit de sommeil de 6 à 8 heures par cycle de travail pour mener à une baisse de performance importante. Et si ce déficit s'accompagne d'affectations de nuit et de longues heures de travail, il peut fortement altérer la mémoire, le traitement de l'information et la vigilance.

Stratégies pour lutter contre la fatigue

Presque tous les pilotes prennent de la caféine et font un somme avant de rejoindre leur affectation. Cela va dans le sens des études montrant que les travailleurs peuvent avoir une performance presque aussi bonne au cours d'un quart de nuit qu'au cours d'un quart de jour s'ils commencent leur affectation bien reposés et s'ils prennent une seule boisson contenant de la caféine (Horne & Reyner, 1996). Cette stratégie se révèle utile même aux personnes fatiguées, qui peuvent ainsi maintenir un niveau de performance meilleur que si elles n'avaient rien fait.

Beaucoup de pilotes sont conscients de l'importance d'obtenir un sommeil réparateur et ont installé dans leur chambre des stores obscurcissants, des ventilateurs et la climatisation. Toutefois, il existe d'autres stratégies pour améliorer le sommeil, comme celles qui ont trait à l'alimentation, les techniques de relaxation et la connaissance préalable des effets de diverses substances. Malheureusement, ces stratégies sont mal connues.

Recommandations formulées à partir des conclusions de l'étude

Voici les recommandations formulées par suite de la recherche :

- réduire le temps d'attente et l'incertitude quant aux horaires, qui engendrent fatigue et stress;
- réduire le nombre des affectations de longue durée et/ou les répercussions de celles-ci sur la fatigue;
- atténuer la fatigue attribuable au travail de nuit en réduisant la durée des affectations de nuit, en limitant le nombre des affectations de nuit consécutives, en permettant de faire des sommes planifiés au cours des affectations de nuit et en accordant des périodes de repos plus longues entre les affectations de nuit;
- réduire les répercussions des affectations à court préavis sur la fatigue en faisant en sorte qu'elles succèdent à des journées de congé et en interdisant deux affectations à court préavis de suite;
- améliorer le repos entre et pendant les affectations en aidant les pilotes à élaborer des stratégies pour bien dormir à la maison et pendant les siestes planifiées, et en aménageant mieux les lieux de repos aux écluses et dans les timoneries.

Description d'un prototype de Programme de gestion de la fatigue (PGF)

Le programme de gestion de la fatigue comprend les volets suivants :

- cours de sensibilisation au sommeil et à la fatigue pour les gestionnaires et les pilotes;
- lignes directrices pour l'établissement des horaires des pilotes;
- lignes directrices pour la mise en œuvre du PGF (ressources d'appui, processus, responsabilités, etc.);
- processus d'évaluation du PGF.

Objet des lignes directrices en gestion de la fatigue

Les lignes directrices en gestion de la fatigue contiennent de l'information et des conseils pour l'établissement des horaires et pour le suivi et l'évaluation du PGF. Les lignes directrices concernant l'établissement des horaires sont conçues pour s'appliquer en sus des méthodes habituelles de confection des horaires. Elles sont un outil que le répartiteur peut utiliser à sa discrétion, sous réserve des clauses des conventions collectives. Les lignes directrices touchant le suivi du programme donnent des conseils sur la façon de maintenir un contact avec les participants au PGF, sur la diffusion de l'information relative à la gestion de la fatigue et sur l'utilisation de la rétroaction pour enrichir le processus d'évaluation. Les lignes directrices concernant l'évaluation offrent une structure pour évaluer de manière formelle le programme à la fin de chaque année.

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1. INTRODUCTION

1.1 General Introduction

The pilot's main responsibility is to safely guide ships through specifically designated waters without incident. The demand for marine pilots is determined by shipping traffic, which is highly irregular, and pilots can be called at any time of day or night. Marine pilots experience high levels of fatigue caused by long, irregular work schedules and limited opportunities for sleep. Moreover, some individuals may not know and/or adopt adequate strategies to alleviate the adverse effects of fatigue. The consequences of this fatigue to marine operations are deteriorated performance and reduced safety. Fatigue effects in shipping operations have been well documented by many scientists (Buck et al., 1998; Colquhoun, 1996; Colquhoun, 1985; Condon et al., 1988; Davis et al., 1997 and 1998; Parker & Hubinger, 1998; Parker et al., 1997; Rutenfranz et al., 1988; and Shipley & Cook, 1980) and safety officials (TSB reports M93L0001, M93C0003, and M97W0197).

The Canadian accidents led the Transportation Safety Board to recommend to Canadian pilotage authorities to adopt pilotage assignments policies and practices to reduce the adverse effects of fatigue on performance. They also recommended the development of a fatigue awareness training program by Transport Canada to teach pilots how to reduce the impact of fatigue on their job performance. Moreover, two other recommendations of the Ministerial Review of Outstanding Pilotage Issues concerned issues that are linked to fatigue. The first stated that the Laurentian Pilotage Authority should "determine whether and when requirements for double pilotage are valid" and the second concerned the inadequate pool of qualified pilot candidates.

Consequently, the development of a comprehensive fatigue management program (FMP) for marine pilots contributes to meeting these recommendations and identifies work conditions and staffing problems that exacerbate problems related to fatigue.

1.2 Purpose and Objectives

The project objective was to improve marine safety by developing for the pilotage industry an FMP that will contribute to a reduction in fatigue-related accidents and incidents, and provide guidelines and evaluation procedures for programs aimed at other marine personnel.

The purpose of this initiative was to:

Phase 1	Identify fatigue problems experienced by marine pilots.
Phase 2	Develop a fatigue management program that will include fatigue awareness training, strategies to reduce fatigue at work, guidelines to improve pilotage assignments, and monitoring and evaluation procedures.

The elements of Phases 1 and 2 of the project included the following:

Phase 1

1. Literature review
2. Identification of fatigue issues in the marine pilotage system
    a. On-board observations
    b. Interviews
    c. Questionnaire

Phase 2

3. Development of a FMP plan
4. Development of the FMP training components
    a. Trainer's handbook and presentation materials
    b. Fatigue management guide for marine pilots

5. Development of scheduling, monitoring, and FMP evaluation guidelines

6. Preparation of a research report (*Development of a Fatigue Management Program for Canadian Marine Pilots* – TP 13958E), a guide for marine pilots (*Fatigue Management Guide for Canadian Marine Pilots* – TP 13959E), and a trainer's handbook (*Fatigue Management Guide for Canadian Marine Pilots: A Trainer's Handbook* – TP 13960E)

1.3 Approach

Figure 1 illustrates the flow of major steps involved in the project. Figure 2 shows the sub-steps involved in the development of a fatigue management program.

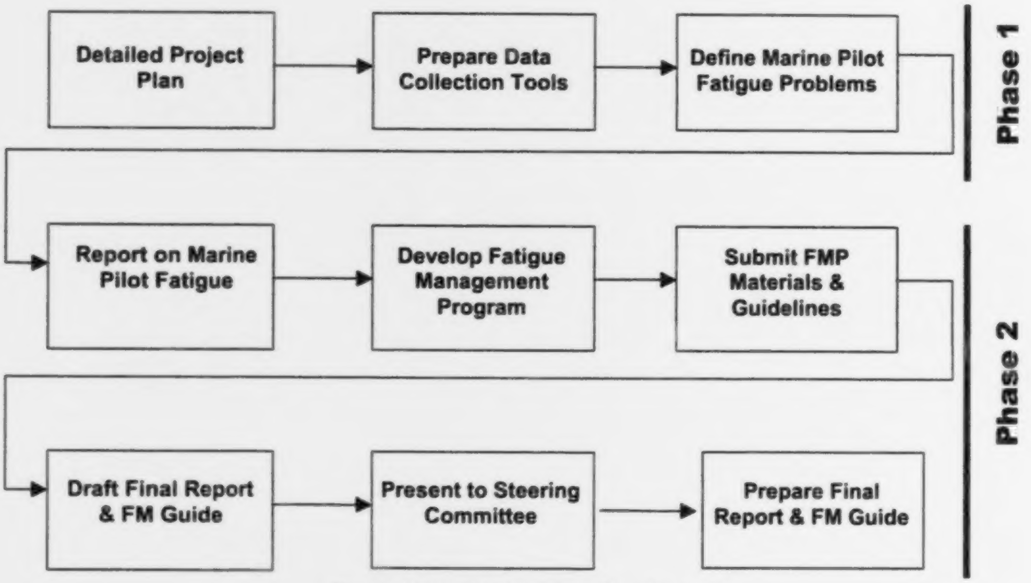
Detailed Project Plan
Prepare Data Collection Tools
Define Marine Pilot Fatigue Problems
Phase 1
Report on Marine Pilot Fatigue
Develop Fatigue Management Program
Submit FMP Materials & Guidelines
Draft Final Report & FM Guide
Present to Steering Committee
Prepare Final Report & FM Guide
Phase 2

Figure 1: Major Steps in the Project

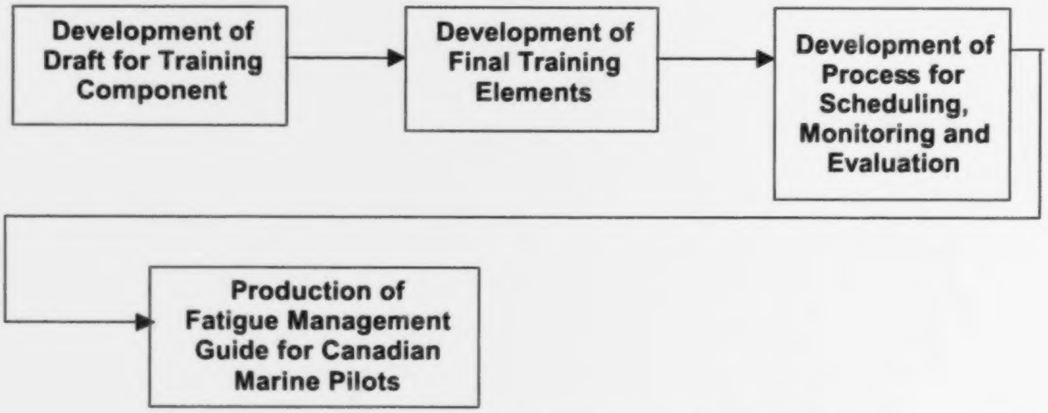
Development of Draft for Training Component
Development of Final Training Elements
Development of Process for Scheduling, Monitoring and Evaluation
Production of Fatigue Management Guide for Canadian Marine Pilots

Figure 2: Sub-steps for the Development of the FMP

2. LITERATURE REVIEW

2.1 Purpose

This literature review focuses on the marine working environment, and particularly on that of marine pilots. The areas of interest include:

- Background information on reasons for concern about the impact of fatigue on marine operations, and the recognition that fatigue may be a major contributing factor to marine incidents;
- The overall impact of fatigue on marine operations;
- The nature of mariner fatigue and its consequences;
- Specific causes of marine pilot fatigue and their consequences;
- Impact of fatigue on marine pilot tasks;
- Fatigue management programs for application to transportation operations and specifically to marine operations;
- Concluding remarks about the literature reviewed.

The materials reviewed included documents obtained from the research literature generally available in journals, periodicals, and edited volumes; research reports produced by various government agencies; training documents produced by government agencies and educational institutions; and monographs devoted to the topics listed above. Library searches were made at several libraries at universities, government and institutional Internet sites, and government libraries. Many fatigue management documents in the Rhodes & Associates Inc. library were reviewed and reported, including instructor handbooks and teaching materials.

2.1.1 Background

The growing awareness of the effects of fatigue on human performance in transportation has led the Transportation Safety Board to make changes in the way incident information is collected. These changes have encouraged incident investigators to look for patterns and signs of fatigue as a causal factor, and to develop techniques to investigate further the validity of this claim. This development has resulted in more complete reports, and has provided valuable information for identifying the etiology of fatigue and its contribution to accidents. The following reports specifically describe fatigue-related incidents that involve Canadian marine pilots. The reports reveal the nature of pilot fatigue, its effect on performance, and the reasons fatigue management programs will be important assets to the industry.

2.1.1.1 Grounding: The Bulk Carrier *Raven Arrow* – TSB Report Number M97W0197

This report describes a grounding that was mostly the result of pilot fatigue leading to poor bridge resource management (BRM). The report indicated that the pilot had been awake for 19.5 hours and was expected to be on watch for another 1.5 hours. The rest and sleep obtained by the pilot were inadequate. This condition apparently led to the pilot's inability to effectively communicate with the bridge crew and utilize their resources to establish the ship's position in low visibility conditions. This lack of information, and the pilot's fatigued state, may have left the pilot confused about the ship's position (poor situational awareness), causing him to misidentify the landmarks used to initiate a change in course. Even the radar presentation was misinterpreted and led the pilot to think that he was actually farther along. He made the appropriate course change at the wrong time (too early) and entered Boat Bay, where the vessel ran aground.

The report points out that the increase in shipping activity during certain seasons and the lack of additional pilots to handle the increase result in pilots working long hours, back-to-back, in order to meet the demand. This causes a situation where pilots become chronically fatigued and unable to perform their job adequately and safely. Furthermore, because of the lack of BRM training for bridge crews, the support needed to prevent errors is missing, setting up a condition where the system is not fault tolerant, i.e., it fails following a single point error. If the officer-of-the-watch (OOW) had been monitoring and plotting the ship's position, and had passed this information on to the pilot, the error made by the pilot could have been caught. Of course, the pilot may have chosen not to believe this information, particularly since he was severely fatigued. However, BRM training does address such situations and teaches strategies that can be used to influence such decisions.

This report contains detailed information about fatigue, the impact of irregular shifts on sleep and performance, the dangers of inadequate rest and sleep, and the value of fatigue management training to make employers and employees aware of such situations. It also offers many diagrams and tables that state, explicitly, the sequence of events that led to the fatigue, the reasons why the pilot found himself in this position, and the inadequacy of pilotage policy and practice to address these problems.

In fact, the report informs the reader that the Great Lakes Pilotage Authority (GLPA) had been required by the Transportation Safety Board to develop and implement a fatigue management program. The recommendation was made five years prior to the grounding of the *Raven Arrow* in the report *Striking by the Bulk Carrier "NIRJA" of the tanker "HAMILTON ENERGY"*. Another report by the States/BC Oil Spill Task Force (July, 1997) discusses the establishment of work/rest standards, in addition to pilot performance monitoring, near miss reporting, BRM training, and other safety related initiatives.

Had the *Raven Arrow* been a tanker, and moving at a higher speed, it may have caused catastrophic damage to the environment. Awareness of fatigue and its effects and possible causes might have prevented this grounding. Management's awareness of fatigue might have encouraged it to look at work practices and assignment policies, and to develop better guidelines for making assignments. Pilots would have been aware of what to consider in their lifestyle and work practices that would have helped prevent fatigue.

It should be noted, however, that improved BRM may have caught the pilot's error and prevented this mishap. Also important is the fact that if the *Raven Arrow*'s bridge crew were aware of the pilot's fatigue, they may have been able to respond appropriately (e.g., request another pilot).

2.1.1.2 Striking by the Bulk Carrier *Nirja* of the tanker *Hamilton Energy* – TSB Report M93C003

This document reports on the striking of a ship by a bulk carrier while negotiating a turn into a slip in Hamilton Harbour. Like the previous report, the document cites fatigue as a major cause of the striking. In this case, the pilot probably did not respond quickly enough to stop the first vessel from striking the second vessel. He had come off from a 22-hour period of duty with no restorative sleep, and did not take the required 12-hour rest period before boarding the *Nirja*.

The report also cites various other problems that may have contributed to the difficulties faced by the pilot. There is some question as to why:

- the ship did not make the turn to starboard successfully;
- the anchor was not deployed in time;
- the tugs were not secured to the ship;
- the main engines did not retard the forward movement of the ship quickly enough;
- the co-ordination of the tugs partially led to, rather than prevented, the striking.

All of these problems are a result of poor judgement and decision making, and may be a consequence of the pilot's apparently high level of fatigue. The cause of this fatigue is a combination of poor judgement on the part of the pilot agreeing to take on the assignment after 22 hours of duty with very little sleep, and the failure of the pilotage authority to recognize the danger of assigning a passage to a very fatigued pilot. The pilotage either did not have a tracking policy in place to identify when a pilot was about to violate the 12-hour rest between assignment rules, or ignored the fact if it was known. The system should be designed to prevent a pilot from breaking this rule except for very special cases like emergencies.

2.2 Method

The literature review was conducted as follows:

- On-line Internet search – sites included:
  - US Coast Guard
  - US Department of Transportation
  - US National Transportation Safety Board
  - US National Research Council
  - Australian Marine Safety Authority
  - University of Southern Australia
  - Transportation Safety Board of Canada
  - Transport Canada
  - Canadian Coast Guard/Department of Fisheries
  - International Marine Organization
  - BEDS and NAPS sleep research on-line data base
  - MEDLINE

- Library search:
  - University of Toronto Library
  - McGill University Library
  - CFoRT Library
  - Institut maritime du Québec (IMQ)
  - Transport Canada's Transportation Development Centre Library
  - R&A in-house library

2.3 Findings

2.3.1 Mariner and Marine Pilot Fatigue

Modern navigation systems and automated ship systems require a smaller crew to do more monitoring and analysing of output from computers than physically operating the ship's systems. As a result of improvements in ship design, cargo handling and port infrastructure, the majority of ships now spend 90% of their time at sea or in pilotage (Quirk, 1999). Changes in the nature of the tasks performed, reductions in crew size, and longer periods at sea have resulted in longer hours of work, shorter rest periods, and increased workloads. This situation threatens to reduce the safety of marine operations and increase the risk of significant marine incidents. This is a classic case whereby design improvements may contribute to increased safety and performance of the system, while staffing changes have negated or reduced any of these benefits. Unfortunately, this incomplete systems approach has not considered all of the human aspects of the operation, i.e., reduced staffing increases workload and fatigue, leading to degraded human performance, ultimately reducing overall system performance. This creates a situation referred to by Reason (1990; 1997) as the "latent conditions" that lead to human errors that increase overall systems risk.

Eighty-nine percent or more of all marine collisions occur as a result of human error (Perrow, 1984). Ninety percent of all maritime incidents occur in pilotage waters (Pelecanos, 2000). Commonwealth investigations reported that 33% of collisions and 24% of groundings occurred during the night (Filor, 1998) whereas the U.S. Department of Transportation estimated that 16% of critical vessel casualties and 33% of injuries had fatigue as a major contributor. Despite new technologies, little has changed, and fatigue in the marine environment is still an issue.

2.3.2 Fatigue in Mariners

Several studies reported similar results (Sanquist et al., 1996; Reyner & Baulk, 1998; Comperatore & Kingsley, 1999; Rutenfranz et al., 1988):

- An overall reduction of one to three hours of sleep when comparing sleep at home and on the ship,
- Fragmented sleep patterns,
- Insufficient rest times when at port or between assignments, and
- Poor environmental conditions in sleeping quarters.

Poor sleep quality in the maritime industry is caused primarily by the work schedule and by the fact that sleep is often attempted at physiologically inappropriate times. In addition, sleep loss can accumulate across days and create chronic fatigue, which cannot be recovered sufficiently during the assignment. Added to this is the fact that sleeping aboard ship can be less restful due to noise levels and the motion of the ship.

Incident investigations showed that individuals involved in incidents where fatigue was a major contributing factor had high levels of fatigue yet most of the companies complied with work regulations, which permit a maximum of 98 hours in one week (Filor, 1998). Hours of work regulations alone will not eliminate the problem of fatigue in the maritime industry. Moreover, a marine tradition that "being fatigued means you are weak" prevents mariners from understanding that fatigue can be as dangerous as moderate levels of alcohol intoxication (Reyner & Baulk, 1998; Filor, 1998; Dawson et al., 1998). Research by Dawson and colleagues (1998) has demonstrated that after a 12-hour shift, fatigue impairs responses, reaction times, logical reasoning, hand-eye co-ordination, and decision making in similar ways as a blood alcohol content of 0.048%.

In response to their work schedule, watch keepers generally obtain their sleep in two or more episodes, which are often taken at times other than at night. This sleep pattern interferes with circadian rhythms and results in more sleep disturbances and shorter sleep episodes than experienced by crew members working a single shift every 24 hours (Sanquist et al., 1996; Reyner & Baulk, 1998). Fatigue-related accidents and laboratory studies have clearly shown that individuals are more likely to make errors and to fall asleep inadvertently during the night (Folkard, 1996a; Monk, 1989). Performance impairment measures indicated poor adaptation of circadian rhythms in response to the mariners' work schedule (Comperatore & Kingsley, 1998; Condon et al., 1988a; Sanquist et al., 1996). Unlike performance, alertness ratings tend to decline only prior to and after each sleep episode. These fluctuations are directly related to watch changes (Comperatore & Kingsley, 1998; Condon et al., 1988a; Sanquist et al., 1996). These results indicated that individuals were not able to accurately perceive the accumulation of fatigue. A fatigue management program would teach them how to better recognize fatigue symptoms. Comperatore and Kingsley (1998) suggest that "this lack of perception of declining abilities mirrors a similar effect of alcohol".

Other factors can lead to sleep fragmentation and circadian rhythm disruptions, such as poor sleep/wake management, additional duties, stress, time zone crossings, weather conditions, and emergencies. Poor sleep/wake management can be illustrated by a mariner electing not to use off-watch time to obtain recovery sleep when needed (Filor, 1998; Rutenfranz et al., 1988; Comperatore & Kingsley, 1998). Additional duties and long assignment duration (greater than 60 days) will also contribute to increasing fatigue by reducing the opportunity for sleep and increasing stress levels related to being away from families (Polkard et al., 1990). Trans-meridian voyages can change shipboard time at a rate of up to one hour per day, thus creating a situation that could exacerbate misalignment between the circadian rhythm and work/rest patterns. Finally, situations involving bad weather or emergency procedures will intensify sleep loss and fatigue symptoms.

We can conclude that fatigue is a significant safety concern in the maritime environment. Suggestions to reduce fatigue include changes in regulations to permit more continuous sleep, better work schedules, marine fatigue management training programs, and physical improvement of sleeping quarters (Reyner & Baulk, 1998; Sanquist et al., 1996; Comperatore & Kingsley, 1999).

2.3.3 Fatigue in Marine Pilots

Marine pilots are local specialists who possess high levels of local area knowledge, ship handling skills and navigational experience. Marine pilots work for an organization (private, government or port authority) that is responsible for providing pilotage services in a particular port or region (Parker et al., 1998a; AMPA, 2000). In Canada the pilots are regulated by four Pilotage Authorities: Atlantic Pilotage Authority, Laurentian Pilotage Authority, Great Lakes Pilotage Authority, and Pacific Pilotage Authority. Pilotage services are essentially a 24-hour safety service, advising the master and navigational officers how to manoeuvre a ship through difficult or high-risk environments. The unpredictable nature of shipping schedules results in irregular work schedules and variable duration of pilot assignments. As a result, many pilots suffer from fatigue caused by inadequate rest, physical and mental stress, or a combination of both.

A detailed study of Great Barrier Reef pilots found that pilots started 50% of their work assignments during the night (Shipley & Cook, 1980; Parker et al., 1998b). The percentage of work at night increased once the time spent travelling to and from the ship was included (Parker et al., 1998b). As a result, breaks between assignments started at all hours and 5 to 10% of them did not follow industry scheduling guidelines. UK pilots had only 39% of their time completely free of duty (not including standby) compared to 75% of typical factory workers (Shipley & Cook, 1980). The majority of pilots reported less sleep (2 to 2.5 hours) at sea than at home, and fragmented sleep (2 episodes or more) often taken at times incompatible with the normal circadian rhythm of the body (Shipley & Cook, 1980; Sparks, 1992; Parker et al., 1998b; Parker & Hubinger, 1998). Ice navigators, who guide ships through ice-infested waters, also report broken sleep of shorter duration than sleep at home (Buck et al., 1998). Australian pilots reported not wanting to leave the bridge for naps because they often felt they could not trust the skills of the crew. If they napped, they took only 10- to 15-minute naps (Parker et al., 1998b). Even though pilots claimed to need less sleep at sea than at home, these results clearly indicate that shorter sleep at sea is a function of work schedules rather than personal choice (Parker et al., 1998b).

The combined effect of consecutive days of sleep restriction and sleeping outside the normal nighttime results in chronic and cumulative fatigue. Reports by Great Reef Barrier pilots of short sleep latencies and high sleep efficiencies despite sub-optimal sleeping conditions indicated high levels of fatigue (Parker & Hubinger, 1998). Interestingly, pilots tended to overestimate their level of alertness since fatigue symptoms occurred on the bridge 58% of the time whereas pilots rated themselves has having low alertness levels only 12% of the time (Parker & Hubinger, 1998). Similarly, only 6% of ice navigators rated themselves as "wakeful-tired – very tired". These ratings were usually given after more than 14 hours on duty (Buck et al., 1998). Stretching, performing light exercise, drinking coffee, and taking a shower were methods used by pilots to combat fatigue symptoms (Parker et al., 1998c). Laboratory studies suggest that two nights of sleep were needed for recovery following a period of sleep restriction (Dinges et al., 1997; Totterdell et al., 1995).

This irregular timing of work assignments is a potential source of stress on pilots' personal lives (Shipley & Cook, 1980; Sparks, 1992; Parker et al., 1998a) and health (Costa, 1996). Another particularly stressful aspect of the marine pilot's job is the time spent on standby waiting for work or a delayed ship. Two thirds of the UK pilots reported waking up too easily and having trouble falling asleep when on call. Moreover, the older they were, the less sleep they got while on standby and the more they admitted using hypnotics to fall asleep (Shipley & Cook, 1980). With increasing age, changes in the sleep/wake cycle makes it more difficult to adapt to irregular schedules (Folkard, 1996a). Another stressful consequence of pilots' irregular schedules is their inability to commit themselves for appointments and social activities, courses, and regular sports and exercise (Sparks, 1992; Shipley & Cook, 1980; Parker et al., 1998a). In addition, it is not only the worker who suffers from the conflict between work and personal life but also the worker's partner and family (Shipley & Cook, 1980; Smith & Folkard, 1993). Given their irregular schedules and the extended period of time spent outside the home, pilots find it difficult to maintain healthy diets and regular exercise habits. Between 30 and 45% of pilots smoked and nearly all of them drank caffeinated beverages, and meals were very irregular (Shipley & Cook, 1980; Parker et al., 1998b). Parker et al. (1998b) reported that 15% of the pilots were overweight and 56% were obese. Pilots' weight problems in association with variable physical demands of pilotage work increase the risk of cardiac stress. Personal characteristics, health and family support are determinant factors in the level of stress and fatigue a pilot will experience.

Rostering systems have a major impact on stress and fatigue. Generally speaking there are stable rosters where pilots are advised in advance of their duty and time off periods, and continually rotating rosters where assignments are given to the pilot whose name is at the top of the list (Shipley & Cook, 1980; Sparks, 1992; Parker et al., 1998a). The stable roster has a greater predictability and will permit the pilot not only to plan family and social activities but also to better manage sleep. A continually rotating roster is highly unpredictable since you never know when your name will reach the top of the list. In terms of fatigue management and job satisfaction, a stable roster has obvious advantages over a continually rotating roster (Shipley & Cook, 1980; Sparks, 1992). The roster type and the policies of a region can produce a negative impact on alertness. Rosters where pilots gain financial benefit from accepting extra assignments will contribute to fatigue. Finally, seasonal fluctuations of traffic and insufficient pilots on duty can result in greater workloads and shorter breaks between assignments, which can lead to acute or chronic fatigue.

On-board and environmental factors have an added negative effect on stress and fatigue. The constant motion, noise and vibration of the ship can interfere with sleep and communication, and in the case of motion it can also result in sea-sickness (Parker et al., 1998b). The design and working conditions of the bridge can impact on stress and alertness levels (Parker et al., 1998b). Modern navigational equipment in good working order has helped reduce workload by giving pilots rapid access to accurate information. On the other hand, a pilot's workload can increase when aboard ships with outdated or malfunctioning equipment. Moreover, bridge systems with adaptable displays where colour and brightness can be changed to accommodate outside environment can reduce strain caused by a variety of lighting conditions (Parker et al., 1998b). Other environmental conditions such as bad weather, poor visibility and high-density traffic can also contribute to fatigue and stress. Of course any improvements in equipment design must be considered in view of the application. Increasing the speed of the ship to improve efficiency, just because new technology increases the ability to avoid collisions, will eliminate any safety benefit (Perrow, 1984).

Erratic work schedules, night work, extended duty hours, lack of time off, inadequate sleep, disruption of family and social life, and unfavourable environmental conditions have interactive and additive effects on stress and fatigue. Consequently, adverse effects of stress and fatigue and their impact on pilot performance are serious potential factors for accidents.

2.3.4 Impact of Fatigue on Marine Pilot Tasks

Risk analysis investigation in Australia revealed that 10 to 25% of marine pilotage accidents can be attributed to pilot fatigue (Det Norske Veritas, 1999). As a consequence of the interactive effects of stress and fatigue, marine pilots may be at an increased risk of exhibiting fatigue induced performance decrements (Parker et al., 1998c). Laboratory studies have shown sleep loss to cause performance reductions in cognitive, vigilance and memory tasks (Dinges et al., 1997; Pilcher & Huffcutt, 1996). Phillips (1998) and Parker and Hubinger (1998) associated piloting tasks or behaviours to fatigue-induced performance decrements described in the scientific literature or by investigators of maritime incidents. Lowered levels of vigilance and memory problems will result in lack of position monitoring, incorrect reading or failure to use navigational information, failure to identify relevant stimuli or risky situations, and lack of effective communication. Slowed reaction time, lapses or micro-sleep episodes are associated with failure to respond to a situation quickly enough to avoid adverse effects. Impaired decision making will result in making assumptions, inadequate planning, inappropriate navigational actions, and incorrect calculations or assessments. Time on task decrements will slow response time to unexpected stimuli and increase errors in judgements and decisions as the work period continues. Finally, fatigued pilots will adopt simpler but riskier strategies such as over-relying on radar and automated equipment.

The majority of Australian pilots identified correct judgement and optimal alertness levels as being highly relevant to pilotage work (Parker & Hubinger, 1998). Sparks (1992) confirmed a strong potential for serious errors of judgement and increased risk of accidents due to cumulative fatigue and circadian rhythm difficulties. He reported that 43% of mariners and pilots had near collisions, experienced errors of judgement and fell asleep while working or driving their car as often as once per month. Performance decrements due to fatigue were most evident during the night and were described as difficulty in maintaining concentration and attention, and memory lapses (Parker et al., 1998c). Fatigue impairs the pilot's situational awareness, decision-making ability, cognitive reasoning, judgement, motivation, mood, and attitude to risk taking and safety (Pelecanos, 2000). Fatigue behaviours in collisions and grounding incidents were mainly failures to keep a proper lookout, failure to use all available information or equipment, misunderstanding and lack of effective communication on the bridge, failure to reduce speed and take avoiding action, and falling asleep (Phillips, 1998). Moreover, situations of high workload could exacerbate performance decrements due to fatigue and lead to an unwanted incident (Parker & Hubinger, 1998).

Using incident reports, investigators found fatigue as a contributing factor in only 8% of collision and grounding incidents (Phillips, 1998). The US Coast Guard Research and Development Centre found that 16 to 33% of US coastal water casualties had fatigue as a causal or contributing factor (McCallum et al., 1996). However, Filor (1988) suggests that up to 30% of maritime incidents could be related to performance impairments due to chronic fatigue. He points out that unless fatigue is explicitly presented as evidence, some behaviours resulting from fatigue might be overlooked or attributed to another cause. Consequently, fatigue-related incidents might have been underreported. Incident investigations where fatigue was a contributing factor showed higher frequencies of fatigue behaviours during night watches and lower frequencies during morning and day watches (Phillips, 1998). Folkard (1996b) described similar 24-hour patterns of accidents in road transport and industrial situations. He proposed circadian rhythms of sleep propensity in association with time on shifts as possible contributing factors.

Unfortunately, one of the greatest dangers associated with fatigue is the ability of human beings to convince themselves that their performance remains unaffected (Pelecanos, 2000). As a result, there is a need to protect some pilots from themselves, as well as from the work group and the industry as a whole (Shipley & Cook, 1980). Given the vulnerability of pilot performance to fatigue, and the potential consequences of such fatigue, minimizing the risk for accidents by optimizing of work practices through appropriate fatigue management strategies is essential. Helping the pilots become more aware of the effects of fatigue on their physiology and performance, and of the consequences of their resulting actions will allow pilots to know when they are working responsibly. Providing them with effective strategies to manage fatigue will help them achieve greater levels of performance and safety. Informing them of lifestyle issues can help improve off-work activities, relationships, and personal satisfaction.

2.3.5 Fatigue Management Programs and Initiatives

Clearly there is a need for pilot organizations to properly address the issue of fatigue. The traditional approach – and sometimes the only one – has been through the use of hours of service laws or hours of rest and work regulations. However, fatigue prevention requires a comprehensive and integrated approach that addresses not only hours of service but also documentation and investigation of incidents and accidents; education and training of customers, management, employees and partners on the management of fatigue; scheduling and rostering practices; workplace conditions; and readiness for work. A fatigue management program that consists of all these components is more useful and successful. We will discuss the usefulness of these components and review some of the education and training modules that have already been developed. Finally, we summarize specific considerations for the design of a fatigue management program for marine pilots.

2.3.5.1 Hours of Service

Hours of service do not provide any flexibility and can potentially cause more fatigue by requiring workers to restrict their sleep and rest when they may not need it or at times that do not take into account their circadian rhythm (Poore & Hartley, 1998; Moore-Ede et al., 1996). Regulations can also promote the use of schedules and rosters that disrupt sleep and increase cumulative fatigue, such as 10 hours of work and eight hours of rest, which creates an 18-hour day (Poore & Hartley, 1998; Moore-Ede et al., 1996). Moreover, regulations providing for eight hours of rest do not permit eight hours of sleep, and sleep quality will differ if the eight hours are taken during the night or during the day. It is critical to develop new hours of service that reflect our current scientific knowledge on fatigue. Finally, enforcement of regulations targets the worker, who often has very little control on his or her schedule (Poore & Hartley, 1998).

Unfortunately, even in situations where hours of work regulations provide reasonable rest and work periods, compliance with existing hours of service regulations will not eliminate the problems of fatigue.

2.3.5.2 Documentation and Investigations of Incidents

First, all unsafe incidents must be recorded and this information should be used to target unsafe practices and prevent future injuries and damage (Poore & Hartley, 1998). A fatigue management program should also include a method of assessing the impact of fatigue and its role in incidents and accidents (Rosekind et al., 1996b; Gander et al., 1998; Poore & Hartley, 1998; Lovell, 1999). Continuous fatigue evaluation improves investigation protocols by examining relevant physiological factors affecting fatigue, in addition to the existing report of falling asleep episodes (McCartt et al., 1998; Lovell, 1999). Factors affecting fatigue include the duration of continuous wakefulness, sleep and work history over several days (which determines acute and cumulative sleep loss), sleepiness risk factors (snoring, sleep disorder) and the time of day of the accident (Gander et al., 1998).

2.3.5.3 Education and Training

A successful fatigue management program requires the active participation of administrations, owners, operators, and managers (i.e., due diligence) in learning about conditions that lead to fatigue, and how they can contribute to a culture of safety (Comperatore & Kingsley, 2000; Filor, 1998). Tepas (1993) suggested several principles to guide the development of educational programs. They should be relevant and specific to the targeted group. Educational programs should recommend behaviours that are practical and easily followed. Recommendations should be limited so they can be easily remembered and used by the workers. Improvement will take time and will mostly occur through new workers and their families following the programs. Education programs should supplement, not replace, improvement in work schedule practices. Finally, education programs should be evaluated to determine their efficacy.

Education materials should: explain the physiological mechanisms that underlie fatigue and how these mechanisms are affected by the work schedule; identify factors and recommend strategies to manage and reduce fatigue; cover fatigue-related performance impairments; and discuss nutrition, health, social and family issues (Gander et al., 1998; Rosekind et al., 1996b; Moore-Ede et al., 1996). Since irregular work schedules affect the lifestyle of spouses and partners, they should also be invited to attend the education programs.

2.3.5.4 Scheduling and Rostering Practices

A key factor in managing fatigue is the way work periods are scheduled. After following education programs, schedulers and administrators should be able to understand the importance of designing and implementing schedules that do not create undue fatigue (Comperatore & Kingsley, 2000). Scheduling practices should consider biological, economic, and social factors, but they should minimize the risk to people's health and safety (Shipley & Cook, 1980; Gander et al., 1998; Lovell, 1999). Other factors to consider are the timing of the shift, its duration, standby or waiting time, and the duration of breaks. Schedules should be arranged to maximize the opportunity for the worker to recover from the effects or onset of fatigue. A minimum of two full nights is needed to recuperate from sleep loss (Dinges et al. 1997; Totterdell et al., 1995). Ideally, a roster should be regular and predictable, but when this is not possible, as much notice as possible should be given prior to duty. Unpredictable work hours should be minimized since they are stressful and they have a negative impact on sleep quality and consequently on alertness (Shipley and Cook, 1980, Sparks, 1992; Parker et al., 1997; Moore-Ede et al., 1996). Finally, records of rosters and actual time worked should be kept in order to assign work in accordance with the worker's recent work-rest history (Mahon, 1998; Poore & Hartley, 1998).

Future scheduling systems will incorporate physiological findings on fatigue such as sleep and circadian considerations (Rosekind et al, 1996b; Dawson et al., 1999). The Centre for Sleep Research in South Australia has designed a risk control model to evaluate rosters' impact on fatigue.

2.3.5.5 Workplace Conditions

The workplace must provide environments that assist in the prevention of fatigue (Mahon, 1998). Consideration should be given to the design of workplaces and equipment to provide proper rest and food facilities, and proper levels of lighting, noise, temperature and vibration.

2.3.5.6 Readiness for Duty

Workers and employers have shared responsibilities in ensuring that the worker is in a fit state to safely perform his or her duty (Dawson et al., 1999, Mahon, 1998; Poore & Hartley, 1998). In practice, the employer is responsible for ensuring that schedules provide sufficient time for rest, recovery and social and domestic responsibilities, as well as proper workplace conditions to prevent fatigue. Employees are responsible for using their time off in a responsible manner to ensure that sufficient sleep and recovery are obtained. They should be aware of the impact of a second job, insufficient sleep, consumption of drugs and alcohol, and other activities on their state of fatigue and consequently on their capacity to work effectively and safely (Dawson et al., 1999, Mahon, 1998; Poore & Hartley, 1998).

2.3.5.7 Education and Training Modules

Tepas (1993) points out the important difference between information and education. Information is communicating knowledge and facts whereas education instructs and trains to develop, learn and use the information. Effective education programs require methods to ensure the understanding, retention and application of the information offered as well as high levels of motivation and time investment on the part of workers and their families. Education is the only way to address the potential impact of non-work related activities on fatigue (Gander et al., 1998).

Training materials should provide workers with the knowledge necessary to better manage their fatigue. The following training modules were reviewed: *Shifting to Wellness* by the Keyano College (1995), *Shiftwork Like Clockwork* by Beyers et al. (1998), *Ice Navigator Fatigue Module* by Rhodes & Gil (1998) for Transport Canada, *Practical Living for Shiftworkers* by Baker et al. (2001) for the University of South Australia, and the NASA Ames *Fatigue Countermeasures Program* by Rosekind et al. (1994).

The Keyano Module is a general training module aimed at shiftworkers and their families. It presents the information briefly with a few figures, and whenever possible it uses personal inventories to help the worker understand the information. After a very short background on shiftwork and the biological clock, the module covers the factors affecting the worker's tolerance to shiftwork and changes the workers and their families can make in their lifestyles to better cope. Coping strategies offered are usually in the form of tips from which the worker can choose. This module would be of limited use to a worker with an irregular schedule.

The Porcupine and Sudbury and District Health Units commissioned the development of a fatigue management training module and shiftworker's guide, called *Shiftwork Like Clockwork* developed by Beyers et al. (1998). This set of documents consists of a trainer's handbook and a shiftworkers' reference guide (Shapiro et al., 1998). The contents of the handbook include general hints for trainers to use when teaching the module, overheads and handouts, suggestions for presenting the content, and an extensive bibliography. The module uses humorous illustrations, hands-on exercises, and basic scientific content, and employs an interactive approach that encourages participants to relate their experiences and opinions. The shiftworkers reference guide is a "self-health guide" that is concise and well illustrated, covers most of the important areas, and includes additional material on recipes for shiftworkers.

The Southern Australia (Baker et al., 2001) module was based on work done for the Australian Railways and the industry. This module is aimed at industrial and transportation shiftworkers. The information is broken down into 14 sections, with case studies and exercises. The exercises are meant to be used by the trainer to evaluate the information learned and certify the completion of fatigue management training. In addition to the kind of information given in the Keyano module, the Southern Australia training module talks about the impact of fatigue on performance, and about napping and commuting. The module not only offers strategies that can be used at home, but also at work.

The Ice Navigator Fatigue Module (Rhodes & Gil, 1998) module was aimed at a very specific group of workers. The module was developed for training instructors teaching the Transport Canada Ice Navigator Training Course. The information is divided into four components (sleep fundamentals, the biological clock, the impact of irregular work shifts, and coping strategies), with several figures and tables. The component objectives are presented in the form of questions that could be used for evaluation. A series of checklists and inventories is given at the end of the module to assess various aspects of the "student's" fatigue, sleep patterns, chronotype, and coping strategies. In addition to the topics discussed in the previous modules, this module offers information on the specific effects of irregular shifts, crossing time zones, and environment on sleep, fatigue and performance. A greater focus was given to strategies for irregular work schedules and the fact that ice navigators spend long periods away from home.

The NASA Fatigue Countermeasures training module (Rosekind et al., 1994) was designed to teach trainers about fatigue management and the delivery of this material to their trainees. This module uses examples from the aviation industry, particularly flight operations. However, the course has been given to many instructors in a variety of industries. The training module includes several illustrations and focuses on the core topics of the impact of schedules on sleep and circadian rhythms, the impact of sleep loss and circadian rhythms on performance, proven alertness management strategies, and future strategies. The module is a logical result of years of research on the impact of fatigue on pilots and the underlying causes of this fatigue (see Rosekind et al., 1994; Gander et al., 1998 for a summary of this research).

2.3.5.8 Specific Considerations for Designing a Marine Pilot Fatigue Management Program

There is ample evidence from the literature for a strong potential for fatigue and the need for appropriate and well-monitored fatigue management programs in the marine pilot work environment (Parker et al., 1997). Marine pilot fatigue management programs should include new work/rest guidelines, education on fatigue, and implementation and maintenance of fatigue management programs (FMP). One important characteristic of pilot culture is the suppression of weaknesses such as feelings of fatigue; this attitude can bring a lot of resistance to change (Shipley & Cook, 1980). The key ingredients for a successful FMP are the recognition of the problem of fatigue and the involvement and commitment to change of all stakeholders. More specifically, employers are responsible for the proper management of all work-related causes of fatigue, and pilots are responsible for the appropriate management of non-work related causes of fatigue (i.e., due diligence). Marine pilot FMPs should provide fatigue information to pilots in order to maximize the benefit of their rest period to obtain sufficient sleep and rest in order to come to work fit for duty (Dawson et al., 1999; Lovell, 1999). Support must be given to pilotages that have positive policies to prevent fatigue (Filor, 1998).

Work-related changes include better and more accurate forecasting systems for pilot booking to reduce standby time and undue delays (Shipley & Cook, 1980; Lovell, 1999). Pilotages should have computer-based systems to record the number of passages taken by pilots along with embarkation and disembarkation times (AMPA, 2000). In fact, the accurate assessment of hours worked should start when pilots are called to service and end when they are relieved from their duties (Lovell, 1999). Relaxing rooms where pilots can lie down and rest when waiting for their ship should be provided (Lovell, 1999). Finally, risk control models using actual worked hours rather than rostered hours should be used in pilotages to evaluate rosters' impact on fatigue (Dawson et al., 1999; Lovell, 1999).

2.3.5.9 Program Evaluation

A proper evaluation of the fatigue management program during its implementation is critical to determine its efficacy. This can be achieved by forming a group to implement testing protocols that document rest opportunities, environmental conditions and crew efficiency in using their rest periods. The evaluation should reveal whether the workers are consistently offered rest periods in proper environmental conditions and whether they take advantage of them (Comperatore & Kingsley, 2000).

Tolerance to shiftwork is improved if the persons are committed to scheduling their lives and especially their sleeping habits around their jobs. Successful fatigue management programs will require fundamental changes in cultural attitudes where everyone recognizes that fatigue is a shared responsibility and is committed to address the work- and non-work related causes of fatigue.

2.4 Conclusion

There are no simple solutions to eliminate fatigue created by 24-hour operations. Humans are genetically determined to sleep at night and be awake during the day. Shiftwork, irregular schedules, crossing time zones, and continuous wakefulness create sleep and circadian disruptions that translate into fatigue and sleepiness. It is likely that fatigue as a contributor to accidents and incidents has been underestimated. Fatigue in the marine pilot has multiple and interactive causes, and different situations impose different demands on the individual. By examining the causes of fatigue, one can identify and develop solutions that incorporate fatigue-related knowledge. Fatigue management relies on the shared responsibilities and co-ordinated actions among workers, employers, government agencies, scientists and the public. Essentially, everyone must understand why change is needed and how the changes will work. The challenge is to incorporate fatigue management programs that meet both operational and physiological demands while maintaining health and safety.

The onus for accepting an assignment should not be on the pilot, because fatigued individuals often cannot determine their true level of fatigue since the fatigued state degrades judgement and decision-making performance. The pilotage authority should be the entity that governs the scheduling of pilots according to a set of guidelines that determine which pilots are ready to perform. The pilotage authority should then have the ability to select only those pilots who meet the guideline criteria for assignment.

The success of fatigue management initiatives relies on support from the pilots and their association, and the pilotage authority. Such support can be made available by making all parties aware of the rationale for the scheduling guidelines and their associated criteria. The appropriate information can be conveyed in a training component as part of a fatigue management program, along with refresher sessions provided to reinforce acceptance. Information on how pilots may improve their sleep, prepare themselves for upcoming assignments, and keep themselves alert during assignment can be part of this training.

3. REPORT ON MARINE PILOTAGE FATIGUE ISSUES

3.1 Introduction

Phase 1 of the development of a Fatigue Management Program for marine pilots in Canada consisted of a literature review and an assessment of the extent of fatigue in the existing marine pilotage. The approach for the latter component of Phase 1 involved:

- speaking with marine pilots about their experiences with fatigue;
- observing them in their work environment; and
- querying them on a written questionnaire that focused on their sleep patterns, the impact of their fatigue on work performance, tasks that are most affected by their fatigue, and the impact of their fatigue on their social, family and personal life.

The results reported here are intended to provide the information required to guide the FMP development process and content developed in Phase 2 of the project. The researchers fully recognize the dedicated and responsible approach that marine pilots take in their job at all times. In fact they were impressed with the high levels shown for both attributes. However, since the human body is limited, work situations are sometimes complex, and the environment is unpredictable, it is paramount that strong awareness of fatigue is pervasive, and that sound fatigue management practices, based on both marine pilot experience and scientific knowledge, prevail.

3.2 Method

3.2.1 On-board Observations

Marine pilots were observed while performing their piloting duties aboard ships on various portions of the Great Lakes system operated by the Great Lakes Pilotage Authority (GLPA). Casual interviews were also conducted with pilots during appropriate portions of the trip. The choice of transits for the observations was based on the following criteria:

- transits that were representative of all GLPA districts such as river, lock, lake, and docking procedures;
- operations that were pseudo-representative of the other Canadian pilotages, i.e., long duration transits, and coastal and port navigation; and
- night transits.

The transits selected included:

- Iroquois Lock to Cape Vincent;
- Cape Vincent to Snell Lock;
- Port Weller to Lock 10 in the Welland Canal;
- Port Huron to Thunder Bay.

Appendix A contains the observational checklist and recording sheets used.

3.2.2 Interviews

Interviews were conducted in the St. Lambert Pilot Office. These were structured and took about 40 minutes to complete. Pilots were asked questions pertaining to sleep patterns, fatigue-related issues regarding piloting tasks, ship conditions, work environment, and scheduling and hours of work issues. Six pilots were interviewed.

3.2.3 Questionnaire

The questionnaire is contained in Appendix A. This survey tool was developed in conjunction with TDC, the pilotage (GLPA), and marine pilots. It was tested with four pilots and revised according to their input. The questionnaire was sent out to all practising marine pilots in the GLPA system by GLPA as part of the bi-weekly pay package, with a letter from GLPA. The questionnaire was accompanied by a stamped envelope that had Rhodes & Associates' Montreal office address printed on the front. The pilots were asked to place their completed questionnaire in the envelope and drop it in the mail. This method ensured that complete confidentiality of the information would be guaranteed.

The questionnaire data was entered into a Microsoft Excel spreadsheet file, and the analysis was performed using the NCSS statistical package.

3.3 Results

3.3.1 On-board Observations and Interviews

Four trips were made in order to make on-board observations of pilots' work environments and to better understand how they could be affected by fatigue. Two trips were made on the St. Lawrence River through the night on freighters of from 180 to 197 metres. One trip was a short call taken from Iroquois at 02h45 and ended at Cape Vincent at 09h30. The second trip started at Cape Vincent at 17h25 and ended at Snell at 03h15. Both ships had Ukrainian crews, few of whom spoke adequate English. For one captain, it was his first time on the St. Lawrence and he was very tired and on edge by the time he reached the Cornwall district. The pilot was able to convince him to get some sleep once they were out of a lock. Both ships had all the essential equipment with proper navigational aids (maps, shipping notices...). Lighting was very low through the night (required to see properly out of the windows), noise was medium to loud (low frequency) and the ventilation was good. Weather conditions were ideal (clear night, calm sea, great visibility).

Navigation was done by giving commands to alter the course and change speed when necessary. The pilots were vigilant and often checked to verify that their command was properly executed. From time to time they used the radio to communicate with other ships or with the seaway authorities. The most critical manoeuvres on these trips were ship crossovers, shallow areas and lock entries. High levels of skill and vigilance were required to line up, enter and position the ship in the locks at Iroquois, Eisenhower and Snell. The pilot communicated with lockmasters over VHF radio, and with linesmen using a walkie-talkie.

A third trip was made on a 90 metre Norwegian freighter. The assignment started at about 16:30 and ended about 02:00. The first two hours were spent circling in Lake Ontario just outside of Port Weller, waiting for ships to clear the locks. This is a common situation, resulting in increasing the duty time to about 10 hours. This ship had very modern equipment with variable pitch propellers and sophisticated navigational aids. Only one crewman was needed on the bridge to operate the ship. Lighting was low at night as expected, noise was medium to loud (low frequency) and the ventilation was good. Temperature on the bridge was controlled. Again, weather conditions were ideal (clear night, calm sea, excellent visibility). The pilot elected to manoeuvre the ship himself, since fine control was required in the locks, precluding the need to give rudder and speed commands to the master. The pilot communicated with lockmasters over VHF radio, and with linesmen using a walkie-talkie. As was observed during the river trips, a high level of skill and vigilance was required to line up, enter, and position the ship in the locks.

The seven lock transits were handled so well that the captain was visibly grateful to the pilot and the pilot's apprentice, and was obviously happy that his ship had been delivered to Lock 7 with skill and care. Since his ship was narrower across the beam than many of the ships using the locks, more skill was required to ensure that the ship hugged the wall of the lock. The captain knew this and voiced his appreciation. This trip involved a great amount of concentration since the locks were a short distance apart. There were only short sections of canal that allowed the pilot to ease up his level of attention. Ironically, the last part of the trip involved going through three consecutive locks. This required the pilot to be constantly vigilant of the ship's position in the locks during the elevation process and while moving from one lock to the next. By the end of this assignment, the pilot was showing signs of fatigue, although not of a debilitating nature.

Finally a fourth trip was made from Port Huron to Thunder Bay. This required crossing Lakes Huron and Superior by way of St. Mary's River. The nature of this trip was similar to the previous trips involving transits with little traffic, and very clear and calm conditions. It differed in that it also involved long expanses of open water. Boredom is the toughest part of such transits, hence maintaining attention is difficult. The most that is required is to check the ship's heading, the traffic ahead and behind, and any ship needing to cross. Often, if the crew is competent and the conditions are good (clear visibility, low traffic levels, and calm waters), the pilot can retire to the pilot's cabin if one is available and sleep. This was ideal during this trip since the assignment started at 04:30 and the most difficult navigation was to come from about 20:00 until 04:30 the next morning (transiting St. Mary's River and lock system). Clearly, to do this part of the trip, the pilot needed to be well rested. Under less ideal conditions the amount of sleep may have been less, and fatigue levels may have been much higher.

Once the ship was clear of Whitefish Point, the pilot turned in for some sleep, leaving the ship in the hands of a highly competent crew. The pilot was able to get about five hours of sleep during each of the lake transits, but found the sleep during the second transit more refreshing and restful. The pilot appeared to be alert and only mildly fatigued by the time the docking in Thunder Bay was completed. This was remarkable since the pilot was suffering from a bad cold that left him with noticeable nasal congestion and a sore throat. His performance during the docking appeared to be flawless, an observation also shared by the captain, who seemed duly impressed by the result. Clearly, the sleep obtained during the lake transits helped the pilot both maintain high levels of performance and keep a cold at bay.

This trip was handled by a single pilot. Usually the pilot is relieved at De Tour where another pilot boards the ship and the first pilot debarks. This second pilot is also relieved after the St. Mary's River transit. The back-to-back assignments worked by the pilot in this instance would normally be a worse-case scenario; however, the circumstances of this trip made it less so. However, in poor weather conditions such as fog or a winter storm, a poorly trained crew who spoke very little English, and a ship in poor condition, the outcome may have been different. The pilot stated that under such circumstances he would have got much less sleep, and he probably would have been more fatigued.

3.3.1.1 Pilot Scheduling and Assignment Process

Pilot work is assigned using a "tour de role" process where assignments are given to the name at the top of list. This type of roster is highly unpredictable and pilots never know for certain when their name will reach the top of the list. They only know that they will be required to board a ship sometime over the next 12 hours. Peak times of activity for the GLPA are around the opening (spring) and closing (fall) of the seaway. GLPA will assign two pilots to pilot a ship when the buoys are not in the water, or in unusual situations such as piloting a cold ship (a ship without heat in the winter) or for some cruise ships. The majority of pilots felt that the level of staffing was generally adequate.

3.3.1.2 Bridge Work Environment

Working conditions vary from very good to very poor. Worst conditions include ships with no appropriate heating and/or defrosting equipment, and crews that are fatigued or inexperienced.

Pilots will generally use their experience or learn on the job to adapt to the different configurations and equipment of each ship. The basic equipment needed by the pilots to effectively do their job are: radar, compass, rudder indicator, engine speed (RPM) indicator, GPS (for speed verification), VHS radio and walkie-talkie to communicate with linesmen at locks and docks. Some pilots also use a portable computer with an Electronic Chart Display Information System (ECDIS).

In order to control the ventilation and temperature on the bridge, pilots will open or close the doors. For lighting conditions they will use the lights available or use a flashlight or sunglasses. Only in extremely cold weather, and as a last resort, will they ask for more heat (if available).

The majority of pilots mentioned that language difficulty (poor English/French) and lack of knowledge by the crew make their job more difficult, stressful, and/or fatiguing.

3.3.1.3 Pilot Tasks

The most frequent or important tasks performed by the pilots were:

- Checking rudder position, ship's speed, heading, and position;
- Communicating with ship's crew, lock masters, linesmen, other ships, and the seaway;
- Looking ahead, staying vigilant, searching for obstacles;
- Taking note of the position of navigational aids and landmarks;
- Watching the ship's movement and behaviour to determine whether there are idiosyncrasies;
- Issuing helm and speed commands; and
- Verifying whether commands are done properly (listen for read-back).

All of these tasks have been found to be sensitive to fatigue-induced performance impairments (Parker & Hubinger, 1998; Pelecanos, 2000). Fatigue reduces a person's ability to concentrate and focus, necessary elements in effective vigilance. Lowered levels of vigilance result in lack of position monitoring, incorrect reading of or failure to use navigational information, and lack of effective communication. Fatigue also impairs the pilot's situational awareness (Pelecanos, 2000) and may leave the pilot confused about the ship's position, causing him to misidentify the landmarks used to initiate a change in course. Reduced communications with crew may hamper co-operation, interfere with access to key information and increase everyone's level of stress. Fatigue causes complacency and increased levels of introversion that degrades the overall ability of the pilot to attend to vigilance tasks and to communicate effectively with the crew. Fatigue causes forgetfulness, indecision, and impatience. Verification of commands may be forgotten or just skipped in an effort to get on with the task. Commands may be delivered with less conviction. Checks to verify information may be skipped, and a single piece of information may be the basis for decisions. Redundancy in the system quickly disappears. An individual's workload increases considerably when fatigued. It takes more effort to overcome the decrements that occur in memory recall, decision making, vigilance, and responding to multiple inputs.

Pilots may face these kinds of situations during the early part and end of the season. When this happens, it is exceedingly difficult to overcome the fatigue when it reaches extreme levels. The key in these situations is to have adequate staffing and to ensure that all pilots receive adequate rest between assignments and that facilities are available to support the pilot's strategies to obtain rest and maintain alertness on the job. Collective agreements address some of these requirements, but further improvement may require a greater level of support and creative new approaches at the dispatch level.

3.3.1.4 Bridge Communications and Planning

Pilots mentioned that good communication with masters at the beginning of the trip ensures good bridge resource management. They often ask about the ship and tell the captain what to expect during the transit. Most of the time the pilot works according to a procedure honed over the years. Hence, the transit is usually accomplished by directing the ship's crew through verbal commands. This approach works well if the crew is alert and understands English. Problems arise if the crew is tired, a condition that is common while navigating the seaway and Great Lakes systems. Often the master desires that his best helmsmen and bridge officers assist the pilot. Unfortunately, for some crews this involves only a handful of qualified individuals. The result is overuse of these crew members. Fatigue builds over several days to the point where these individuals are grossly fatigued and almost ineffective. Hence, the crew is prone to making errors, a situation that increases the pilot's own levels of stress.

If there is time, the pilot will plan the transit using the appropriate charts. He can calculate the times when landmarks are expected to appear, allowing him to arrive at a fix for course changes. He may want to discuss the entry to a channel or lock with the master prior to arriving there, warning of current or bottom effects, suction with walls, etc. Lastly the pilot may be just interested in allaying any fears that the master may have, size him up for the level of co-operation expected, check for the master's level of fatigue or expertise, or just determine his level of English.

3.3.1.5 Work and Rest

Approximately 50% of a pilot's assignments (around 70 trips per year) are at night (between 00h00 and 06h00). This percentage is similar to the percentage of night assignments reported by Great Barrier Reef pilots (Shipley & Cook, 1980; Parker & Hubinger, 1998). Most pilots working in District 1 and Cornwall said that they rarely lacked sleep between assignments because of the set number of hours of rest that they must take between calls. Consequently, they also said that they rarely experienced difficulties due to fatigue. When they do, they work at a slower pace and increase their effort to maintain attention. Pilots in District 2 and 3 indicated that they also obtained adequate sleep between assignments.

In order to deal with unpredictable working hours, pilots try to be aware of where they fall in the "tour de role" and which ships are coming. This way they can anticipate when they will be called in order to plan a nap in the afternoon/evening or a good night's sleep prior to the assignment. Assignments are usually confirmed a few hours in advance (three to four hours). Pilots wait an average of approximately 15 to 20 minutes for their assignment to start, but under unusual circumstances it can take up to two hours, often because of delays in the ship's progress to the staging area.

Delays or exceptionally good progress during transit or loading/unloading a ship can be unpredictable. If the delay goes on for many hours, the pilot may lose the opportunity to sleep or nap before he must finally board. The problem seems to be due to situations where the dispatcher cannot give adequate warning of a ship's location at a given time. The ship's estimated time of arrival (ETA) at the staging area (where the pilot must board the ship) may change three or four times during the initial wait time. The difficulty appears to arise from the lack of accurate information from agents who track the progress of the ship at the docks, or from the dispatcher who may be trying to co-ordinate many ships and pilots at once. The dedicated telephone line (code-a-phone) that provides updates of ship movements and ETAs is updated every two hours. However, pilots may still get a call from the dispatcher any time, even after pilots have checked the code-a-phone message. This prevents some pilots from being able to relax and obtain good sleep. Being on standby waiting for work or a delayed ship is particularly difficult with increasing age. Constant changes in the sleep/wake cycle make it more difficult to adapt to irregular schedules (Folkard, 1996c).

Pilots from District 1 and Cornwall said they did not have time for regular breaks. They only took the time for washroom trips and ate while working on the bridge. Pilots from District 2 face a similar situation when traffic in the locks does not permit any breaks.

Misunderstanding, not understanding and not letting the pilots know they don't understand are the most common communication problems pilots face with crews, which increase pilot stress and sometimes fatigue levels.

Pilots feel they are more vulnerable to fatigue at night between 04h00 and 06h00 and more specifically at sunrise. Pilots had difficulty identifying tasks that were affected by fatigue and most of them were convinced that their performance remained unaffected. This lack of ability to properly assess the impact of fatigue on performance was also pointed out by Pelecanos (2000) at the Australian inquiry into managing fatigue in transport. When admitting to fatigue-related impairment, pilots pointed to vigilance and visual tasks as being the most affected by fatigue. On-board observations of pilots permitted the consultants to observe that pilots occasionally gave the opposite command to the helm or officer-of-the-watch (OOW) for rudder and engine speeds at the end of the assignment, a time when they are less alert. This performance decrement is evidently due to fatigue and could be worse in situations of high workload performance impairments and lead to an unwanted incident. However, in every instance they immediately corrected the command and the crew responded correctly. In fact the helmsman was more likely to make an incorrect course change, where the pilot had to respond with "the other port" or the "the other starboard", always resulting in the helmsman correcting his direction on the wheel. Since crews are limited in number, the more capable bridge crew members were often used for more watches than they probably should handle. It was observed that the ship's bridge crew members were often more tired and less sharp than the pilot. On the other hand, one bridge crew was exceptional and showed high levels of alertness. Of course, this crew also showed exceptional capability overall.

Training new pilots contributes to fatigue by increasing stress levels and the demand on vigilance. Motion discomfort is infrequent, especially on the river portions of the transit. Malfunction of equipment can also cause fatigue due to waiting periods to do the repairs. One of the most fatiguing situations described by pilots involved enduring long stays at a dockside while waiting for other vessels to take their turn going through the locks. This may happen many times during a trip up or down the canal. By the end of an assignment in which waiting occurs, the pilot will likely have to work extra hours beyond the norm for the transit. The combination of waiting, the added stress of explaining this to the ship's master, dealing with the dock masters and increased duty time can be quite fatiguing.

3.3.1.6 Driving

Some pilots have cabs drive them to and from work. It takes them between 10 and 60 minutes. Others drive their cars and take between 45 and 120 minutes to get to and from work. After an 11-hour transit, sometimes accomplished with little prior sleep, a pilot may be quite sleepy on the drive home. Two Laurentian pilots went off the road and were killed on their way back to Quebec City from Trois-Rivières. It was surmised that the driver fell asleep. The provision of cabs to ferry pilots to or from their homes or designated meeting areas is an excellent safety measure and helps the pilot to ensure his or her performance on the job. Unfortunately not all cab drivers are rested when they work their shift. In fact, some pilots have been involved in car accidents while riding as a passenger in a cab. Many cabs are in poor repair and may even be unsafe. Sometimes pilots may be able to nap in the cab during their trip to the staging area or lock. Napping prior to starting a shift is a strategy that is recognized by many experts in fatigue to be an effective method for enhancing or maintaining work performance, particularly on a night shift. The pilots appear to be happy with this arrangement, although experiences with cab drivers with poor driving performance has at times reduced the effectiveness of this strategy. For this strategy to be more accepted, the GLPA may need to look at the possibility of arranging such a service with a more conscientious, reliable contractor. The GLPA may also need to survey the pilots to determine what aspects of such a service pilots disagree with, and what other alternatives may exist. However, the survey would need to be detailed enough to capture the information required to weigh the pros and cons of all alternatives.

3.3.1.7 Sleep and Napping

Taking very short naps (5 to 10 minutes) on board ships seems to be possible for trips going through locks. Since these naps are short, they are usually taken in a chair on the bridge while waiting at the lock. Naps can also be taken on trips on the lakes, especially on longer assignments. Longer naps (30 minutes and more) can be taken in a cabin provided by the captain of the ship. However, as was also pointed out by the Australian pilots in the study on Great Barrier Reef pilots (Parker & Hubinger, 1998), GLPA pilots reported that they would not leave the bridge for a nap when they felt they could not trust the skill of the crew.

Family situations will affect the pilot's ability to nap prior to a trip. Pilots will either find their nap interrupted by their children or they won't be able to nap if they are alone with a young child. The nature of the waiting that occurs when trying to establish a realistic ETA for a ship's arrival at the staging area can be an added stress and make sleeping before the assignment very difficult. Some pilots, however, said that waiting for the call does not seem to affect their sleep. As one puts it, it is just a matter of sleeping until the phone rings. This will, of course, depend on the time of day. Sleep between 20:00 and 22:00 is poorer and may not be possible, according to a number of pilots interviewed. This is consistent with the research on circadian sleep/wake rhythms that show that people have the most difficulty sleeping two to three hours before their habitual sleep time. This period of increased arousal is called the "forbidden zone for sleep" (Lavie, 1989). Consequently, it is not surprising that some pilots complained that it is sometimes impossible to get proper sleep immediately prior to an assignment that starts in the late evening.

3.3.2 Results from Questionnaire

This section contains the results of the survey sent to all GLPA pilots. Response was roughly 44% (N=31) of the total of 71 pilots who received the questionnaire. Unfortunately, low response from the District 1 and Lake Ontario pilots (Figure 3) reduces the level of representation and precludes any comparisons between districts for responses to questions, since low response in certain districts would make it obvious how individual pilots had answered, compromising the confidentiality. However, data based on the entire sample is valid enough to generalize for the majority of pilots. Many of the questions deal with issues of fatigue, sleep patterns, and the impact of irregular work hours on various aspects of their lives. These are areas common to all of the pilots.

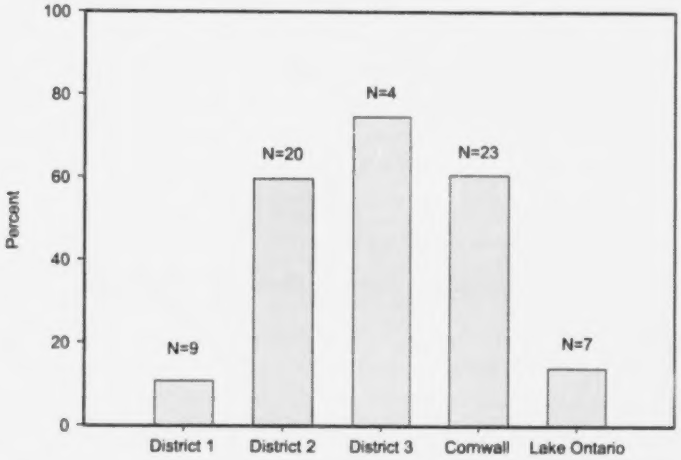

Figure 3 – Representation for Each District

3.3.2.1 Demographic Information

Table 1 contains the basic demographic information for the respondents to the survey. All pilots are married or living with a partner, and half have children living at home. Approximately 90% of the pilots drink caffeinated beverages and only 13% are smokers.

Table 1 – Age, Experience, Marital Status, and Children for the Total Number of Respondents

Total N	Mean Age (yrs.)	Experience (yrs.)	Marital Status					Children	
			Married	Single	Sep/Divorced	Widowed	Remarr	Yes	No
31	50.4	12.2	29	0	0	0	2	14	17

3.3.2.2 Hours of Work and Rest

This section deals with the hours of work and rest reported by the pilots.

Duration of Assignments

Figure 4 illustrates the mean percent for assignment duration. The collective agreements for all of the districts do not stipulate a maximum for assignment duration. Hence approximately 16% of the assignments go well beyond 12 hours. Unexpected delays during lock transit and lake crossings can be 16 hours or more, and may require that the pilot be vigilant for a large proportion of the transit.

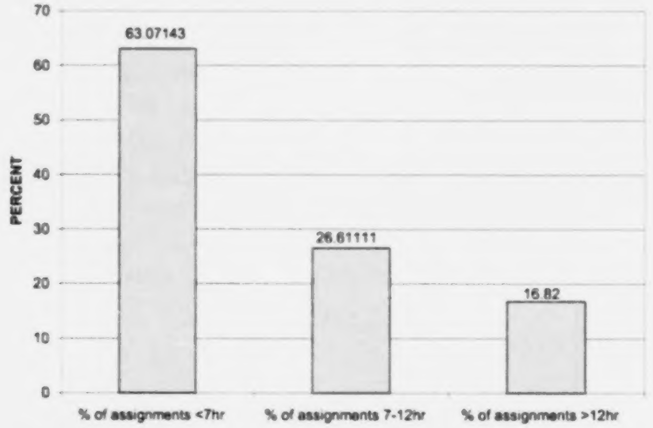

Figure 4 – Percent Means for Duration of Assignment

Time Off Between Assignments

Figure 5 shows the number of hours off between assignments for each category of duration (<7 hrs.; 7 – 12 hrs.; and >12 hrs.). The distribution for each category is relatively even, although many pilots have more hours off following assignments that are less than seven hours in duration, and less than after the longer 12-hour assignments. To ensure adequate recovery, longer rest periods should follow long assignments and night assignments.

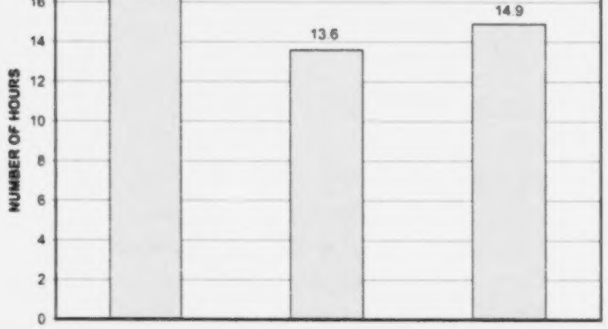

Figure 5 – Mean Hours for Time Off Between Assignments

Figure 6 shows the distribution of answers for the question regarding how often pilots work during their days off or during holidays. Almost 70% reported that they sometimes work on their days off, and approximately 30% reported that they sometimes work during their holidays. About 8% reported that they work often during their days off.

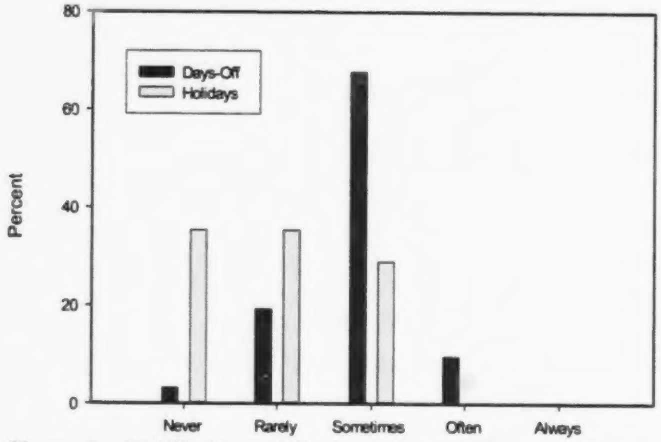

Figure 6 – Distribution of Work on Days Off and Holidays

Short Calls

The collective agreements for District 1 and Lake Ontario allow short calls to occur in certain circumstances (not stipulated). Other districts do not stipulate rules on short calls. Short calls were reported to occur at least an average of nine times a season for the majority of pilots (71% – see Table 2). It is not clear how much rest time is lost, on average, but it can be assumed that when these situations occur, fatigue may be an issue.

Table 2 – Work at Night and Short Calls

Short Calls		Amount of Night Work (%)
Number of pilots taking short calls	**Average # of short calls per year**	
22 of 31	9.29	47.03

Satisfaction with the Tour de Role and Acceptance of Assignments

Some pilots (17.86%) reported that they are not satisfied with the dispatch process (Table 3) and suggested that having access to seaway information via the Internet would improve the dispatch process. Some pilots (16.13%) reported that they accept assignments outside of the tour de role. Situations where this occurs include:

- when maintaining a Canadian presence in Thunder Bay as harbour pilot; and
- during the St. Clair – Detroit River Tours where the rest period is not always used.

Table 3 – Satisfaction with Dispatch Process and Acceptance of Assignments Based on Tour de Role

	Yes (%)	No (%)
Tour de role	83.87	16.13
Dispatch process	82.14	17.86

Worst-Case Assignments

The following worst-case assignments were described:

- any assignment between 12 and 24 hours (working the equivalent of two shifts in a row);
- bad weather in combination with extremely long assignments (36 to 57 hours) and incompetent crew;
- working four to six nights in a row; and
- unexpected calls at night in bad weather on a ship that handles poorly with an incompetent crew.

3.3.2.3 Fatigue

This section includes the findings for the causes of fatigue, effects of fatigue, and the tasks most affected by fatigue.

Causes of Fatigue

Work Task and Environment

There are numerous causes of fatigue, both within the work environment and outside of it. These causes can combine to increase fatigue and can sometimes lead to serious decrements in performance. Marine pilots work in an environment where many stress-related pressures can increase fatigue, including:

- long hours of work;
- irregular hours;
- extreme weather conditions and temperature;
- ships that are in poor condition and ill equipped;
- crews that are fatigued and poorly trained, and lack fluency in English;
- inadequate sleeping quarters aboard ship precluding restful sleep; and
- extremely high or extremely low workload.

Figure 7 illustrates the levels at which pilots rated the fatigue caused by each of these work-related stresses.

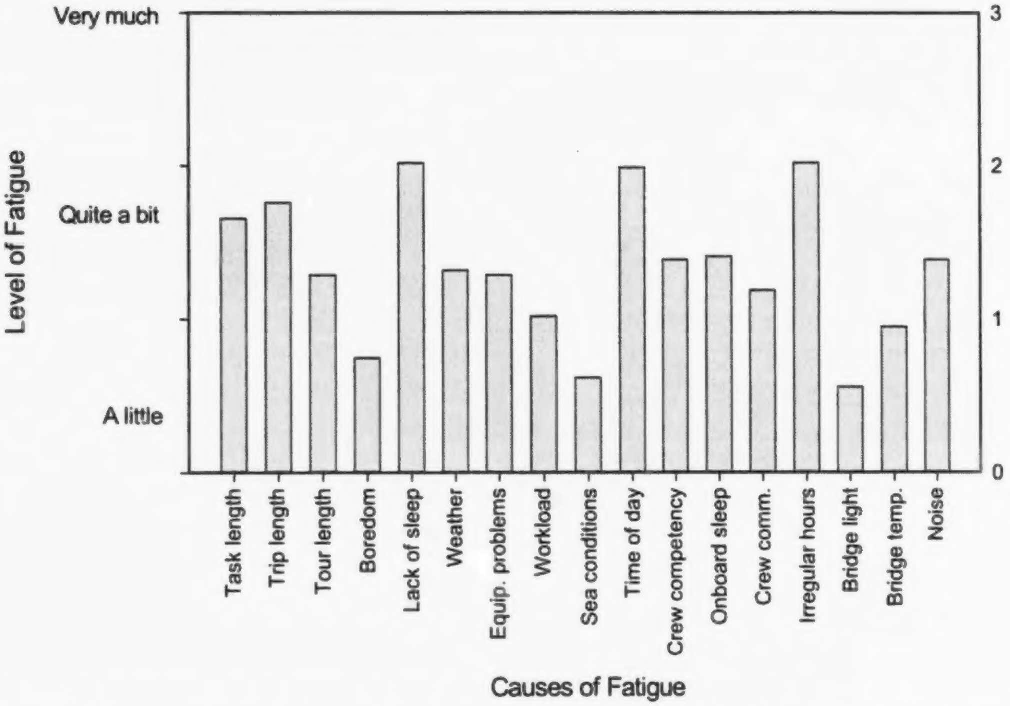

Figure 7 – Mean Score for Each Factor Contributing to Feelings of Tiredness and Fatigue

Note that the main work-related causes rated by the pilots as reaching the level of quite a bit (relatively high) are:

- irregular hours;
- time of day;
- lack of sleep;
- trip length; and
- task length.

Table 4 lists the top 10 tasks identified by the pilots as contributing most to feelings of fatigue. Note that tasks or conditions involving vision, continuous attention and concentration are among the most fatiguing.

Table 4 – Top 10 Tasks Contributing to Feelings of Fatigue and Reasons Why

Task	Reasons
1. Visual watch at night	Requires lots of attention, weariness, eye fatigue.
2. Work with radar in poor weather	Virtual images, poor quality of radar.
3. Bad weather	High stress, more concentration and attention.
4. Manoeuvres	Requires attention, stressful.
5. Heavy traffic	Requires concentration, no time for napping.
6. Ship difficult to steer	Repeat order frequently.
7. Crew competency and communication	Difficult to understand, frustration.
8. Constant watch of instruments	Stationary position, constant attention.
9. Synchronizing with other ship	Constant mental arithmetic.
10. Waiting	Tiring.

Causes of Fatigue Outside of the Work Environment

The top five causes of fatigue outside of work are:

1. Lack of sleep at home
2. Sickness or crisis at home
3. Waiting for assignment (standby)
4. Family obligations
5. Social obligations

Age

Age also can have an effect on how we perceive and experience fatigue. Figure 8 indicates that as pilots age they become more susceptible to the impact of weather, trip and task length on their perceived fatigue. Trip and task length had been found in a previous question to be two of the main contributing factors of feelings of fatigue regardless of age. It is not surprising that age differences are important since most pilots in the system at the moment are over 40, and half of them are over 50. It will be some time before younger trainees enter into the industry. At the moment most new pilots are experienced mariners who are over 30 years of age. Figure 9 shows that age also has a bearing on the impact of fatigue on simple tasks and reaction time. Older pilots noted a greater impact of fatigue on their reaction time and performance on simple tasks.

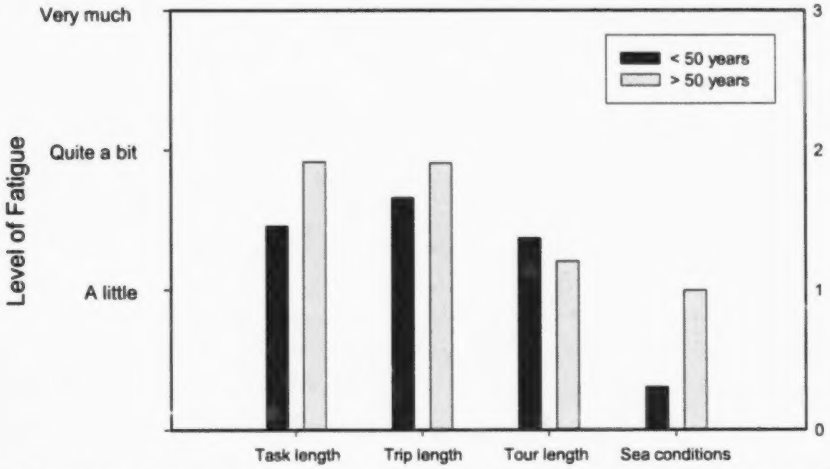

Figure 8 – Impact of Age on Some Industry-Specific Factors Contributing to Fatigue

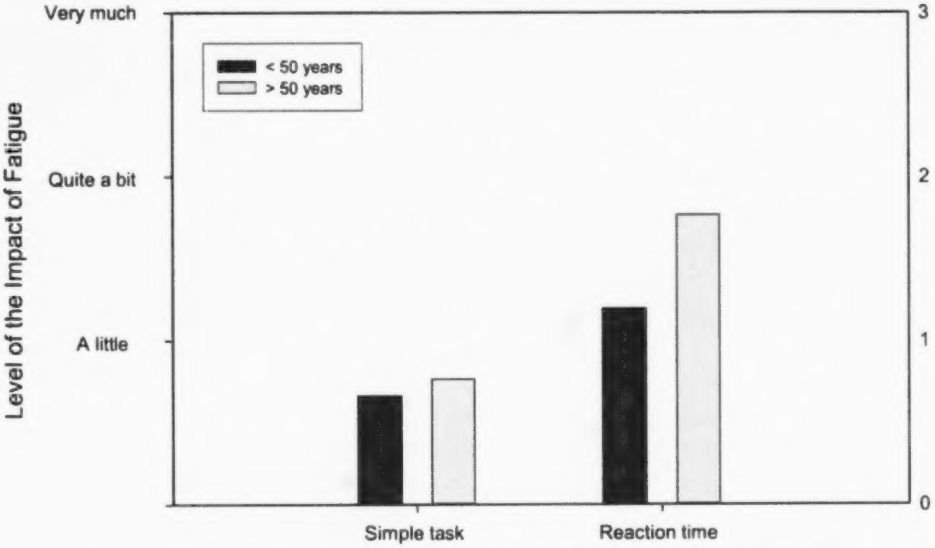

Figure 9 – Mean Score for the Factors Affected by Fatigue and Age

Effects of Fatigue

Fatigue affects many areas in our lives including work, family, friends and our own health and well-being. Greater levels of fatigue not only make it difficult to perform at work, but can make getting along with family and friends stressful.

Tasks Affected by Fatigue

Figure 10 shows the ratings given by the pilots for the impact of fatigue on several typical tasks.

The main tasks most affected according to pilots are:

- decision making;
- attention;
- keeping awake; and
- reaction time.

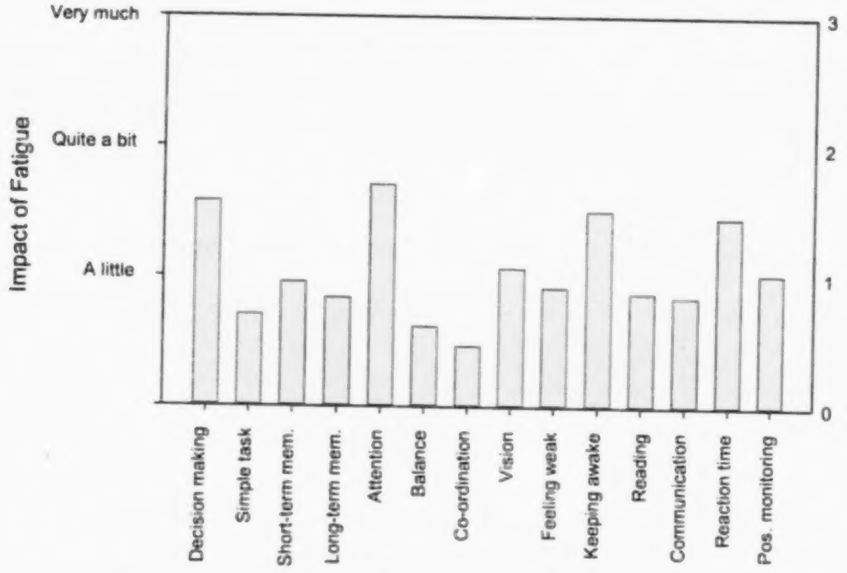

Figure 10 – Mean Score for Each Factor Affected by Fatigue

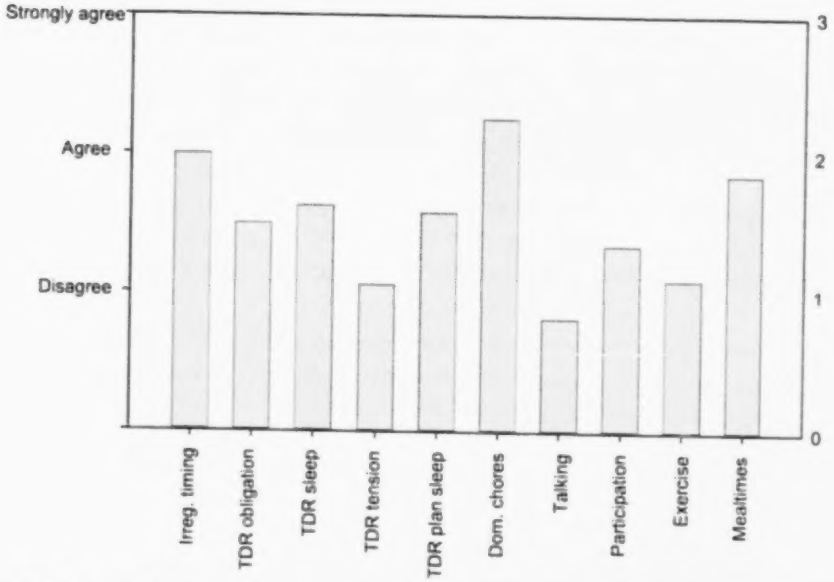

Figure 11 – Impact of Variable Factors on Family and Social Activities, and Sleep

Figure 11 shows the results for questions regarding the impact of irregular hours of work and tour de role demands on family and social obligations, and the usefulness of certain strategies to reduce this impact. Pilots found that irregular timing of assignments and being on call interfere mainly with planning family activities, accomplishing domestic chores and maintaining regular mealtimes.

Worst Times of Day for Fatigue

Table 5 shows the times of day for the start or finish of a work assignment that are most likely to cause fatigue. It is interesting to note that the time most likely to lead to fatigue, as indicated by the pilots, is just prior to going into a night assignment. Also, the second most fatiguing time to start an assignment is from 03:00 to 06:00. These are times when the body is normally either getting ready for sleep, or in deep sleep.

Table 5 – Frequency of End/Start Times that Are the Most Fatiguing

Start Times	Frequency (%)	End Times	Frequency (%)
21:01 to 00:00	64.28	0:01 to 03:00	14.28
00:01 to 03:00	35.72	03:01 to 06:00	75.00
03:00 to 06:00	0.00	06:00 to 12:00	10.72

The most fatiguing time to end an assignment according to the pilots appears to be just at that time when the body is approaching the lowest point in the circadian rhythm i.e., the nadir. This is a time when the body's alertness and vigour are beginning to wane. Keeping awake to end an assignment at that time of the day requires more effort than at any other time of day.

Callbacks

According to the pilots, the impact of callbacks is small, and sleep and social/family responsibilities appeared to be the main activities negatively affected (Figure 12). As mentioned earlier, if time is taken from days off to work, it is at the expense of sleep and family time.

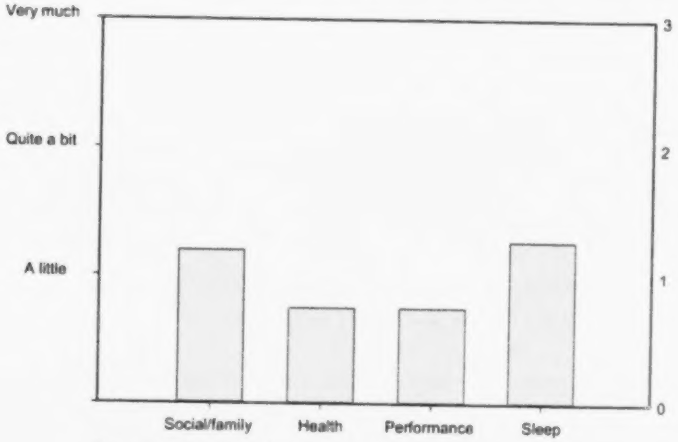

Figure 12 – Factors Affected by Callbacks

Impact on Driving Performance

One good indication of fatigue levels is to examine the prevalence of incidents where the driver has nodded off while driving. Many of the pilots did not answer this question because almost all (96%) take cabs to work and back home again. Figure 13 illustrates the mean incidence level for those pilots who answered the question (n = 22). The rate is less than that seen for other professional groups who work irregular hours, probably due to the fact that most pilots don't drive themselves.

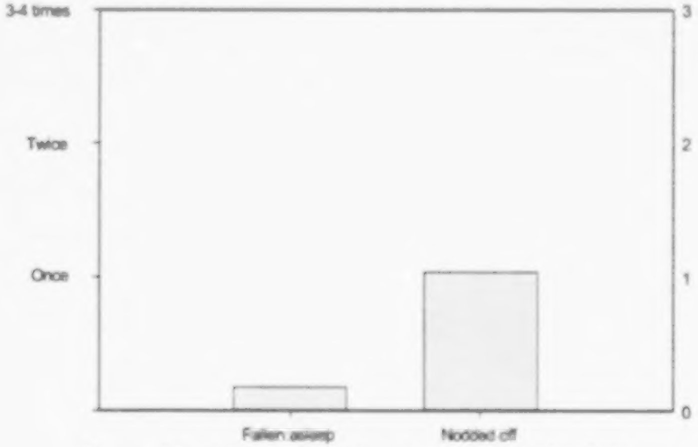

Figure 13 – Impact of Fatigue on Driving (n=22)

Commute Time

The average commute time was 78 minutes, with a range of one to 300 minutes. Presumably the one-minute commute reported was the distance from a nearby hotel to the lock.

3.3.2.4 Sleep Information

Quantity of Sleep

Figure 14 provides the mean for the amount of sleep reported for the various times of day during the work cycle and on days off. Pilots were asked for their ideal sleep in order to establish a baseline for comparison. Note that the sleep reported for daytime was considerably less than the ideal or sleep on days off. It was also significantly less than sleep reported for night during the work cycle. As is the case for other night workers, the average day sleep duration is less than 5 hours. Marine pilots seem to be getting an average of 7 hours of sleep when sleeping during the night after their day assignments, which is almost as much as sleep on days off. This represents from 2 to 3 hours of lost sleep during each day sleep.

Twenty-two pilots also reported a mean frequency of three days per work tour of duty for which they got less than five hours of sleep. Hence the potential for fatigue is high given the fact that pilots must often get by on reduced sleep, building a sleep debt throughout their tour of duty.

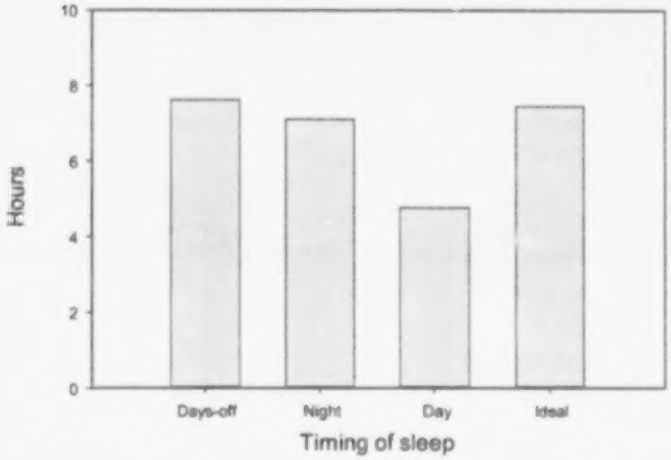

Figure 14 – Sleep Duration Under Various Conditions

Opportunities for Sleep

Sleeping facilities are almost always available to pilots aboard ship (Figure 15). Facilities aboard ships are sometimes adequate for proper sleep. Pilots sometimes use the facilities aboard ships if the opportunity arises or the facilities are acceptable for use. It is notable that the facilities in pilot offices are reported as rarely adequate and only sometimes available, and are used very little by the pilots. Most pilots sleep poorly to very poorly when sleeping in the pilot office (Figure 16). In contrast they sleep well to very well when sleeping at home. One pilot pointed out that there are many times that pilots could use a good sleeping facility at the office (or lock facility) while waiting for ships to arrive at the staging area or lock.

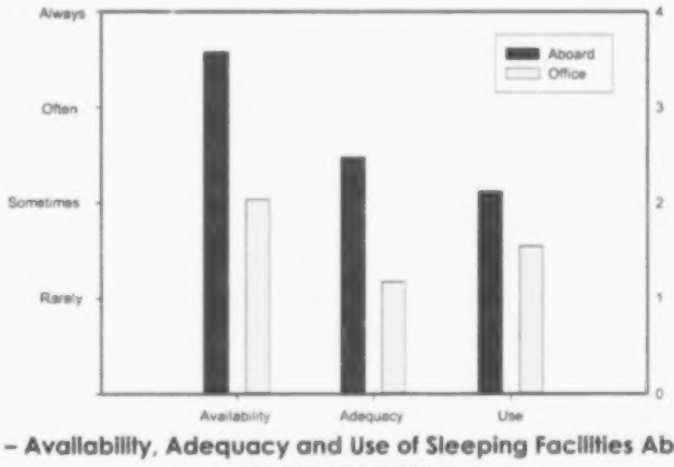

Figure 15 – Availability, Adequacy and Use of Sleeping Facilities Aboard Ship and at the Pilot Office

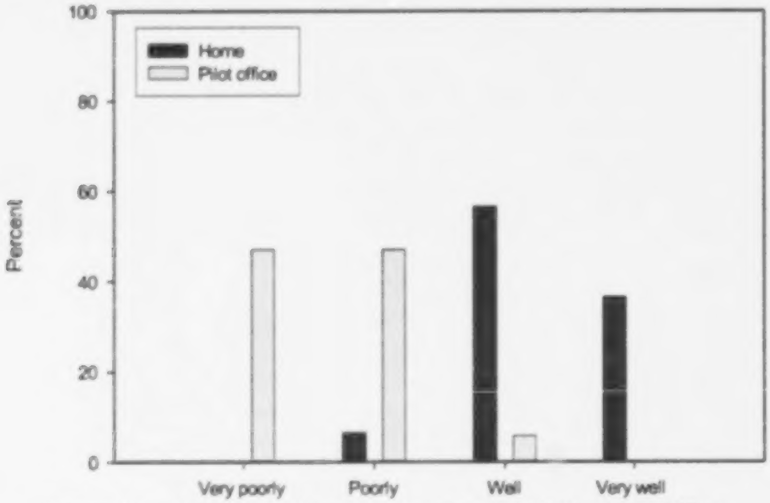

Figure 16 – Quality of Sleep at Home and at the Pilot Office

Napping

Figure 17 shows the percentage of marine pilots who nap in different locations and on different occasions. Note that almost 40% of the pilots said they nap aboard, although only 12.9% reported they took naps while at work to reduce fatigue (Table 6). It is also interesting to note that naps are used not only to alleviate fatigue while on board, following an assignment or a particularly tiring shift, but also between and in preparation for assignments.

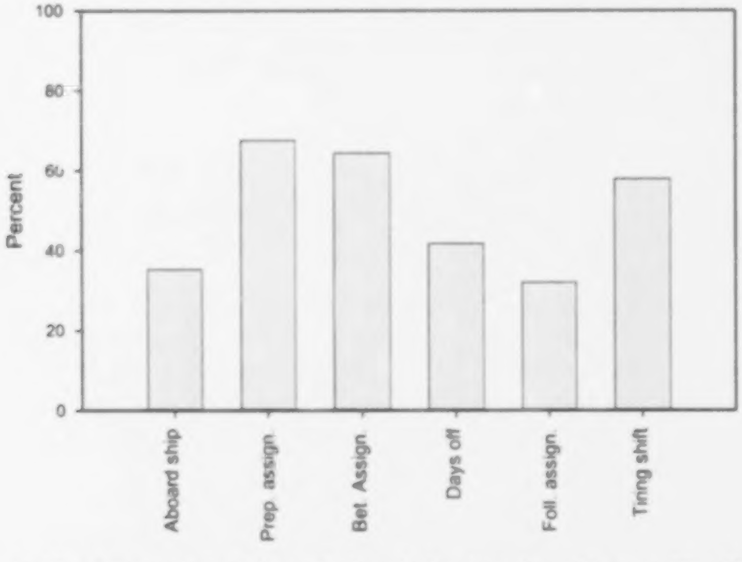

Figure 17 – Frequency of Naps Taken in Various Locations or Situations

Table 6 lists the conditions that prevent napping on board ship as reported by the pilots. More than half of the respondents indicated that work demands prevent them from napping aboard the ship. Almost as many listed crew competency as a condition that prevents napping, since these pilots were uncomfortable leaving a poorly trained and performing crew to their own devices. Approximately 40% of the pilots listed poor sleeping conditions as another condition that prevents them from napping on the ship.

Table 6 – List of Conditions Preventing Napping Aboard a Ship

Conditions	Frequency (%)
Work demands	58.06
Competency of crew	41.94
Poor sleeping quarters	38.71
Can't nap	12.90
Employer doesn't allow it	3.23

Table 7 lists the conditions that are conducive to napping aboard ship. These conditions are all low- or no-workload situations. When the vessel is anchored and there is little or nothing to do is a good opportunity and strategy to nap and prepare for the upcoming work. The duration and quality of such naps depend on the situation but are likely to be taken in a chair or couch on the bridge level or in the wheelhouse itself.

Table 7 – List of Conditions Conducive to Napping Aboard a Ship

Conditions	Frequency (%)
Lake crossing	48.39
Docked or waiting at lock	35.48
Waiting for assignment	22.58
Anchor 1 pilot	25.81
Anchor 2 pilots	3.23

Figure 18 shows that sleep aboard ship is often poor, although it appears that sometimes sleep can be acceptable. The conditions listed in Table 6 will often determine how good the sleep will be aboard ship.

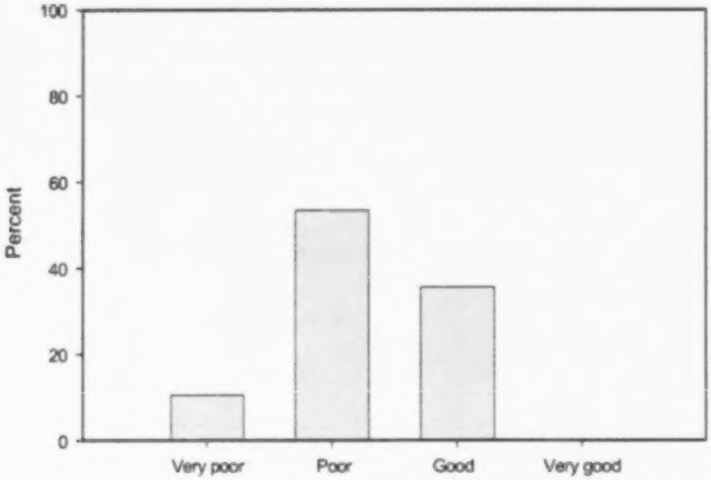

Figure 18 – Quality of Sleep During Naps Aboard Ship

3.3.2.5 Coping Strategies

Strategies Prior to Beginning an Assignment

Table 8 lists the various strategies that are commonly used by personnel working irregular hours. The proportions and number of pilots are listed for each strategy.

Table 8 – Frequency of Use of the Top Five Strategies Used at Home to Prepare for Work

Strategies	Frequency (%)	Number of pilots
Caffeinated drink	96.67	29
Naps	86.67	26
Relaxation	50.00	15
Special diet	20.00	6
Exercise	10.00	3

Most of the respondents indicated that they napped and had a caffeinated drink prior to going into work. These are two proven strategies that help maintain performance through a night shift or at a time when fatigue is degrading performance. Relaxation was selected by 50% of the respondents as a strategy for preparation for the assignment. Given the demands of the pilot's job under some conditions, this is likely to be a very useful strategy. Twenty percent of the pilot respondents indicated that they used dietary choices to help them prepare for an assignment. A few indicated that they exercised prior to heading off to work.

Fatigue Countermeasures Used While Working

Table 9 lists the frequencies for the various strategies that marine pilots use to alleviate fatigue while working.

Table 9 – Frequency of Use of the Top Seven Strategies Used at Work to Alleviate Fatigue

Strategies	Frequency (%)	Number of pilots
Caffeinated drink	64.52	20
Stretch	54.84	17
Drink Water	51.61	16
Eat	16.13	6
Walk	16.13	6
Naps	12.90	4
Fresh air	6.46	2

More than half the pilots take a drink or stretch to alleviate fatigue. Again these are very good strategies to reduce fatigue while at work. The small incidence of napping is likely associated with reasons preventing napping aboard ship, given in Table 6.

Strategies to Obtain a Good Sleeping Environment

Table 10 lists the frequency with which respondents use strategies recommended for obtaining an effective sleeping environment. The most-used strategies include maintaining a quiet sleep environment, keeping the temperature at a comfortable level, and ensuring that the room is dark. Half of the pilots also reported maintaining good ventilation, keeping the bathroom dark, and using a fan for white noise. Thirty percent reported using earplugs, but very few reported using a mask.

Table 10 – The Top Eight Conditions that Pilots Use for Their Sleeping Environment in Order of Frequency

Strategies	Frequency (%)	Number of pilots
Quiet room	80.65	25
Temperature control	70.97	22
Room darkening window covering	67.74	21
Good ventilation	54.84	17
Dark bathroom trip	48.39	15
Fan for ventilation and white noise	48.39	15
Ear plugs	29.03	9
Sleeping mask	6.45	2

Strategies for Preparing to Sleep

Table 11 lists the frequency that respondents reported the use of various strategies for preparing to sleep to ensure that they obtain good sleep. About a third of the pilots used none of these strategies. Reading and avoiding caffeine topped the list with 63% and 60%, respectively. About a third used a bedtime routine, watched TV and/or made sure they avoided strenuous exercise. Very few pilots used relaxation, and only one pilot reported using alcohol or sleeping pills to get to sleep. Both of these remedies are actually more disruptive of sleep and can make sleep less restful.

Table 11 – The Top Eight Strategies that Pilots Use to Prepare for Sleep in Order of Frequency

Strategies	Frequency (%)	Number of pilots
Read before going to sleep	63.33	19
Avoid caffeine	60.00	18
Bedtime routine	36.67	11
Watch TV	33.33	10
Avoid strenuous exercise	26.67	8
Relaxation	9.99	3
Have an alcoholic drink	3.33	1
Take sleeping pills	3.33	1

Table 12 confirms the interest and benefit of an educational component discussing how to obtain good sleep, coping and strategies to stay alert, and the impact of irregular schedules on health and lifestyle. Pilots are also interested in knowing more about nutrition, exercise and circadian rhythms.

Table 12 – The Top 10 Topics Pilots Would Like to Know More About in Order of Frequency

Topics	Frequency (%)	Number of pilots
Obtaining good sleep	67.74	21
Impact on health	64.52	20
Impact on lifestyle	58.06	18
Coping strategies	51.61	16
Strategies to stay alert	45.16	14
Nutrition	38.71	12
Exercise	35.48	11
Circadian rhythms	32.26	10
Sleep disorders	22.58	7
Nature of sleep	16.13	5

3.4 Conclusions

Survey results, on-board observations and interviews show that generally the pilots experience significant fatigue during some transits, particularly long night transits. The results also show that although a majority of pilots have found a balance that works for them, there are still many who would benefit from knowing more about the impacts of irregular shifts and why certain strategies may be effective.

3.4.1 Hours of Work and Rest

Pilots reported that more than 75% of their assignments are less than 12 hours in duration, with more than half being less than seven hours in length (Figure 4). Assignments longer than 12 hours represent approximately 16% of their work. Pilots also reported that half of their assignments occurred at night, including the longer ones (Table 2). Consequently, night assignments and long duration assignments without relief or rest are a main concern for fatigue. The duration of recovery depends on the duration of the assignment and time of day, nights requiring more recovery time than day assignments. During busy periods, a pilot may work several long assignments in a row. In all but two districts the scheduling of assignments is done such that after two night transits, a pilot cannot be called in to work before 06:00 the next day (the 06:00 no call rule). This works well for assignments that are less than 12 hours in length. Unfortunately, after longer night assignments that end later in the day (around early afternoon for instance), a pilot can be called 14 hours later (after 06:00) and still satisfy the rule. After a number of these long assignments, each starting later than the previous one, a pilot's biological rhythms may become badly out of sync. In this situation, pilots may find that it is difficult to obtain the sleep they need. Proper scheduling and tracking of prior assignments would limit this and help reduce fatigue accumulation throughout the tour of duty. Current rest periods between assignments may be inadequate. District 1 has split the transit into two parts so that there is relief at the halfway point, reducing the average transit to 5.5 hours, rather than 11 hours. This strategy is effective in reducing fatigue and risk. Shorter night assignments help alleviate the extra stress caused by working out of sync with your biological rhythms (Dawson & Fletcher, 2001). Providing more rest at the end of two longer night assignments (>7 hours of work) is not as effective in reducing fatigue at the times when the pilot needs it most, i.e., immediately after working through the nadir (lowest point) in the biological rhythm. It does, however, provide extra recovery time for sleep and helps return the body's rhythm to a more normal condition.

A high percentage of pilots said that they regularly worked on their days off, which can result in cumulative fatigue due to a lack of proper rest (Figure 6). The collective agreements for most of the districts do not restrict the number of consecutive days a pilot can work before having to take a rest period. Only the Cornwall District's agreement stipulates that the pilot must take three days off following the 14 or 15 days of their tour of duty during the beginning of the navigation season. The lack of guidelines on the timing of rest periods means that a pilot may work several long nights in a row without a break. This can often lead to considerable levels of chronic fatigue. In practice, the distribution of nights and days may be more even; however, the potential for high levels of fatigue is there. The key to managing this risk is to make sure that all parties – the pilot, the dispatcher, and the GLPA – keep track of the timing of assignments, and that adequate rest periods are properly interspersed into the schedule, where appropriate.

Short calls were not reported by the pilots to increase fatigue but they reported increased sleep loss and difficulties planning family and social activities, which in turn impacts their level of fatigue. Worst case scenarios often involve a long assignment with a crew that is tired, and a ship that is minimally equipped (e.g. no GPS, analogue radar only) and sailing with too little ballast, i.e., sitting too high in the water. The pilot must remain alert, able to monitor the situation and be able to respond to unintended course alterations, crew errors, and worsening weather conditions. Heavy fatigue in these kinds of situations is highly likely. The possibility of relief prior to the end of the transit would need to be considered in order to avoid mishaps due to fatigue. Worst-case scenarios that include several nights in a row for a single pilot could be avoided with better scheduling practices.

3.4.2 Fatigue

The survey results show that generally the pilots report that they experience fatigue during some transits, particularly long assignments, night transits, and at other times when obtaining sleep is difficult. Older pilots report a greater impact of weather, trip length and task length on fatigue. These results are consistent with the scientific literature on fatigue (Folkard, 1996c; Colquhoun, 1996; Parker & Hubinger, 1998). Many pilots use effective strategies to help alleviate the fatigue or to get the sleep they need. However, there is still a significant number of pilots who do not.

Many pilots are aware that piloting performance is most likely degraded by fatigue, and know the situations that are likely to cause them the most fatigue. Causes of fatigue reported by the pilots are consistent with those in the scientific literature (Folkard, 1996c; Colquhoun, 1996). Lack of sleep, time of day, irregular hours, and trip and task length are among the most common workplace fatigue contributors, particularly for marine operations. Lack of sleep, sickness or crisis at home, and waiting for an assignment are among the main causes of fatigue outside the work environment. The management of time and prioritization of activities at home are difficult with irregular hours and in the end, sleep is often sacrificed. If there are not enough hours in the day to get everything done, workers tend to shorten their sleeping time. Add a sick family member to this and demands on time increase significantly, leaving even less time to devote to sleep. Hearing an infant crying in the night or having to attend to a sick child in the middle of a sleep period can further exacerbate an already difficult situation. Trying to fit social and family obligations into an uncertain work schedule is like trying to hit a moving target. Planning activities while on call is almost impossible, and planning for sleep ahead of an assignment is also difficult and may result in missing sleep prior to heading out to a ship.

Pilots report that decision making, attention, keeping awake and reaction time are the main tasks affected by fatigue. Again, the pilots' responses are consistent with the scientific literature. However, the numbers for the effect of fatigue on memory were lower than expected. It would be interesting to find out whether memory is really not affected or if pilots are simply not aware of it.

The fact that some pilots are aware of the causes and consequences of fatigue make an interactive type of workshop the best training approach for the educational component. The educational component can provide a forum in which the information may be shared, and all pilots can benefit from those who have learned from experience.

3.4.3 Sleep

Pilots report that they get adequate sleep in general. Even though they certainly obtain adequate sleep during the night (7.1 hours) in comparison to the ideal sleep duration (7.46 hours), they get only an average of 4.75 hours of sleep when sleeping during the day between or prior to night shifts (Figure 14). Hence, they are deprived of 2.25 hours of sleep for each night assignment. This can accumulate to substantial sleep loss within a week, since half of piloting work is done during the night. If a pilot happens to do three consecutive night assignments, he or she would lose almost the equivalent of a full night's sleep (6.75 hours lost). If some of the night assignments are long, it could result in even greater sleep debt and chronic fatigue during the tour of duty. The longer the shifts and the longer the tour of duty, the more fatigue will be incurred. Sleeping a minimum of seven hours at night after day assignments will help lower the levels of fatigue that build up during a tour of duty. However, only sufficient time off between assignments to recuperate, in combination with a reduction of the number of consecutive night-time assignments substantially reduces the levels of fatigue.

Most pilots use strategies recommended for establishing an effective sleeping environment, but not as many use good strategies to prepare for sleep. Sleeping facilities on board ship are often available and sometimes adequate, whereas they are rarely adequate and only sometimes available in the pilot offices or at locks. Pilots report that they sometimes use the facilities on board ship but rarely do so in the office or at the lock, although they would if the sleeping environment were improved. Work demands, crew competency, and poor sleeping quarters are the conditions that prevent pilots napping aboard ship. These findings are consistent with findings from Australian pilots (Parker & Hubinger, 1998).

3.4.4 Coping Strategies

Almost all pilots use caffeine and a nap prior to going on an assignment. This is consistent with findings showing that individuals can perform almost as well during night shifts as they do on day shifts if they are well rested prior to the assignment and use a single caffeine drink (Horne & Reyner, 1996). This strategy is effective in helping even fatigued individuals to maintain better performance than otherwise would have been the case.

Caffeine is a commonly used strategy to maintain alertness while working, followed by stretching and drinking water. Some fatigue management researchers have recently shown that staying properly hydrated can help maintain alertness (Baker et al., 2001).

Forty percent of pilots reported napping aboard ship but only a few said they nap while working. This discrepancy could be due to the fact that naps taken specifically to alleviate fatigue are a small portion of the naps taken aboard. It is possible that pilots did not include longer sleeping periods aboard ship during lake crossings as naps. Delays while docked at a lock and while waiting for an assignment to begin are times when naps might also be considered.

Finally, pilots realize that the nature of the scheduling, which is often unpredictable, makes applying strategies very difficult. More than half expressed an interest in knowing more on how to obtain good sleep, coping and alerting strategies, and the impact of irregular schedules on health and lifestyle. Most research done on strategies to improve sleep shows that they in fact are effective in increasing sleep efficiency and effectiveness (Hauri & Linde, 1996; Maas, 1998).

3.5 Recommendations

The pilotage authorities would greatly benefit from a fatigue management program plan that addresses the following recommendations and provides specifications for the content of the educational, scheduling, monitoring, counselling, and evaluation components.

1. To reduce waiting time and uncertainty that causes fatigue and stress:
    - Improve dispatch system by making information available on Internet
    - Improve ETA and code-a-phone accuracy

2. To reduce the number of long duration assignments and/or their impact on fatigue:
    - Look at creative ways to reduce assignment duration or provide relief prior to 12 hours
    - Restrict the number of long assignments that can be worked in a given period
    - Provide adequate rest periods between long assignments
    - Give pilots time to plan for longer assignments whenever possible

3. To decrease fatigue during night work:
    - Keep the assignment duration short
    - Reduce the number of consecutive night assignments
    - Provide adequate rest periods between night assignments in order to get restful sleep
    - Increase pilot awareness of fatigue impact on performance

4. To reduce the impact of short calls on fatigue:
    - Ensure short calls are taken at the end of a rest period to minimize their impact on fatigue
    - Minimize the number of short calls taken consecutively and/or within a given period

5. To improve rest between and during assignments:
    - Schedulers must be aware of pilots' previous assignments (hence level of fatigue) at the time of assignment
    - Pilots must be aware of their own level of fatigue before accepting an assignment
    - Pilots must recognize how and when to obtain proper rest prior to or during assignments, if possible
    - Pilotage authorities must provide proper sleeping facilities (i.e., quiet, dark, well ventilated, secure from unnecessary interruptions, and comfortable) at the pilot office and at the locks

The educational component should provide useful details on the effects and efficacy of coping strategies. It should also provide the rationale for using these strategies. A shorter version of the educational component should also be given to dispatchers.

4. DESCRIPTION OF AN FMP PROTOTYPE

4.1 Objectives

4.1.1 Objectives

This chapter describes the components of a marine pilotage FMP. The goal of an FMP is to improve the way in which marine pilots and pilotage authorities view fatigue, its impact, and the means to alleviate it. It is understood that the authorities and pilots are familiar with fatigue and its causes. However, it is clear from the results of major studies discussed in Chapter 3 that many concepts of how the body works, how people make decisions about obtaining good sleep, and how performance is affected by fatigue are not well understood. Scientists have found, for instance, that:

- Humans are poor at judging their own levels of fatigue.
- Humans do not successfully adjust their circadian rhythms to midnight shifts because most insist on sleeping at night on days off.
- Sleeping during the day is never as efficient or restful as sleeping at night.
- Alcohol may help people get to sleep, but within approximately an hour it will awaken them when its stimulating effects begin (Hauri and Linde, 1996).
- Caffeine remains in the body for up to 12 hours, depending on the person's weight and age.
- The impacts of circadian rhythms on performance are significant and can lead to increased risk of making errors.
- Being awake for 12 hours straight results in performance deficits equivalent to 0.05 (50 mg of alcohol in 100 ml of blood) Blood Alcohol Concentration (BAC), which rates a warning under the Impaired Driving Section 253 of the Criminal Code of Canada. In Canada it is an offence to exceed 0.08 BAC, yet after 19 hours of wakefulness, subjects perform as if they had more than 0.10 BAC (Lamond & Dawson, 1999; Williamson et al., 2000).
- Actual brain functioning is significantly impaired (enough to interfere with the ability to remember even simple things, do basic calculations, make decisions, etc.) by moderate sleep deficits (two hours per day) accumulated over a weekly work cycle.
- Disruptions caused by shifts and irregular work hours to meal times, social activities, and family responsibilities can increase levels of stress, degrade health, and affect job performance.
- Naps can help alleviate the negative effects of sleep debts on job performance.
- The ability to adapt to changing circadian rhythms declines as workers age.
- A moderate ability to plan for sleep while working irregular hours or shifts vastly improves an employee's ability to cope with his or her hours of work.

4.1.2 Importance of an FMP Evaluation

Historically, fatigue management has been handled through education only, with few "programs" actually including data gathering, counselling, and evaluation components. Data gathering is important since it allows the program administrators to determine whether the program has actually accomplished its goals.

Involvement of all levels of the pilotage authorities and associations is important to the continuing usefulness and effectiveness of the FMP. The FMP's success will depend on:

- the collection of information by a party who is responsible for monitoring the FMP (usually a jointly appointed FMP co-ordinator);
- the successful running of basic and refresher FMP training by individuals in the pilotage authorities and in the associations; and
- the complete dissemination to all stakeholders of information regarding fatigue, sleep, and shiftwork issues pertinent to the marine and piloting work environment.

The counselling component ensures that:

- any problems identified through data gathering are handled appropriately;
- questions raised by the educational component are answered; and
- support is given to personnel regarding the implementation of recommendations of FMP training.

The FMP evaluation component formally assesses the information gathered through:

- operational procedures (error monitoring and subjective observations);
- feedback from the counselling process; and
- a short questionnaire about success in meeting the specific goals of the program.

Complete fatigue management programs in transportation have been developed only in the last few years. Australia has been leading the way with programs developed for the trucking, marine and rail industries. The Department of Transport of Western Australia has produced a comprehensive set of requirements (code of practice) for fatigue management for motor carriers in Western Australia (DOT-WA, 1998). The Australian Marine Safety Authority is developing a fatigue management program for marine pilots based on its research (Parker & Hubinger, 1998). Dawson et al. (1997) developed guidelines for the Australian railway industry. Baker et al. (2001) have developed a fatigue management approach that when combined with a scheduling software-based tool (Fletcher & Dawson, 2001; Dawson & Fletcher, 2001) can provide most of the components present in a complete fatigue management program. However, follow up and monitoring components are not specified. The Alberta Trucking Industry Safety Association (1998) has developed a complete set of guidelines on a fatigue management program for Alberta motor carriers. The CANALERT program (Moore-Ede et al., 1996) initiated by Canadian Pacific Railway and VIA Rail consists of a set of recommendations for managing fatigue in rail operations. These recommendations could be converted into a set of guidelines for managing fatigue.

A key element for success of any fatigue management program is for all levels of an organization's management to ensure that all support that is necessary to implement the program will be available. This includes provision of rooms for napping, exercise facilities, proper food storage and preparation facilities, provision of adequate breaks timed according to biological as well as operational requirements, and staffing and scheduling that encourage a healthy and productive work environment.

Figure 19 illustrates the relationship of the components for the FMP proposed here. Note that the educational and scheduling components are essential elements in targeting fatigue whereas the monitoring and evaluation components are to assist pilots and to modify the FMP if necessary. Each element can be introduced in successive steps as shown in Figure 19.

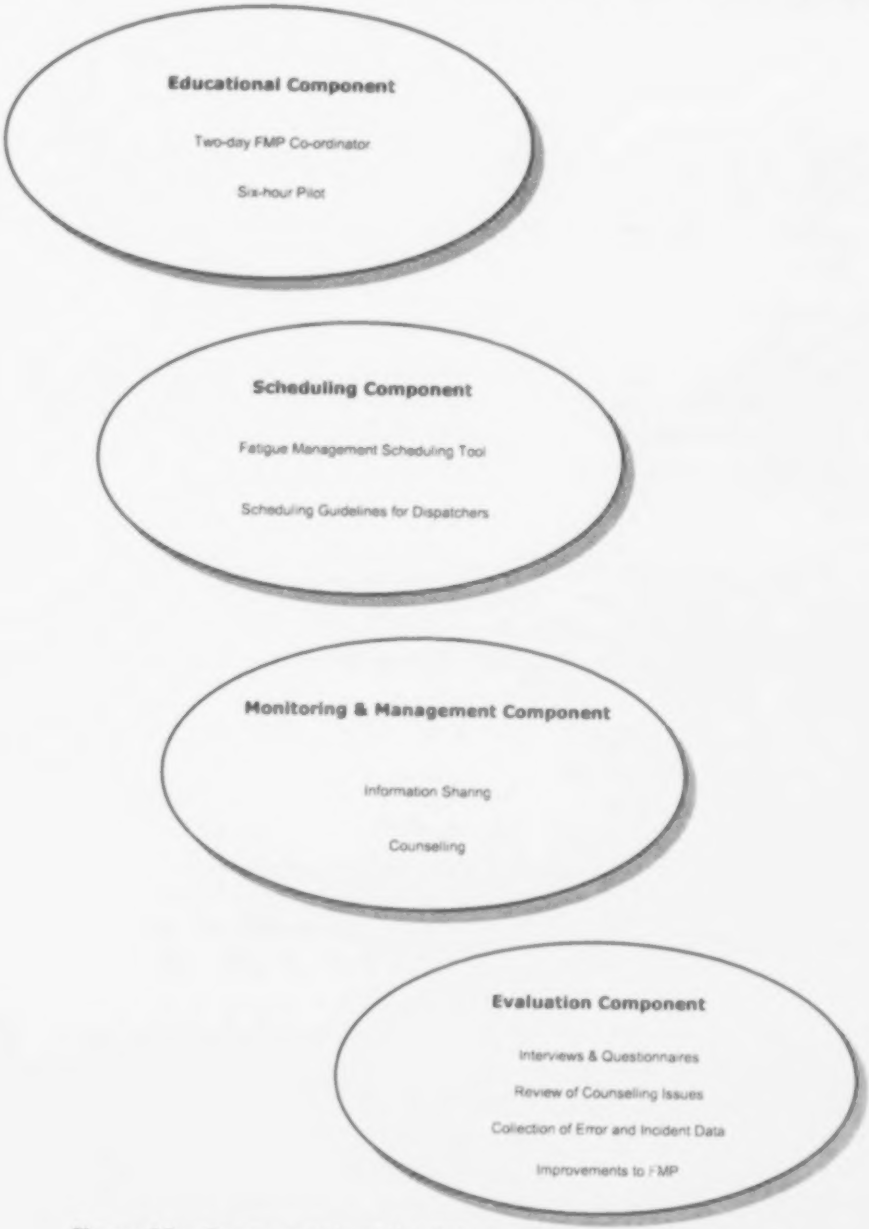
Educational Component
Two-day FMP Co-ordinator
Six-hour Pilot
Scheduling Component
Fatigue Management Scheduling Tool
Scheduling Guidelines for Dispatchers
Monitoring & Management Component
Information Sharing
Counselling
Evaluation Component
Interviews & Questionnaires
Review of Counselling Issues
Collection of Error and Incident Data
Improvements to FMP

Figure 19 – Components of the Fatigue Management Program

4.2 Rationale for FMP Components

4.2.1 Educational Component

The best way for any initiative to be successful is for all of the stakeholders to be informed about the process and benefits of the initiative. Informed individuals can make better choices and will be more likely to adopt and support the process. Individuals and their companies need to see the rationale and value of the FMP, and need to acquire the knowledge required for them to implement coping strategies and fatigue countermeasures in the work environment and at home. This approach applies to many other types of programs such as those concerned with improving health, managing stress, handling critical incidents, reducing substance abuse, and promoting a safety culture. This information sharing must be monitored for effectiveness and reinforced on a regular basis.

4.2.2 Scheduling Guidelines Component

The guidelines will help schedulers and dispatchers use circadian information to review the pilots' levels of fatigue and past rest/work history to identify whether a pilot is potentially fatigued. They can then contact the pilot to discuss the possibility of an alternative assignment arrangement, such as delaying the call-up for a reasonable period of time (e.g., eight hours). This gives the pilot the ability to delay his commitment for a given period of time to obtain needed sleep during particularly busy periods. Fletcher & Dawson (2001) have worked out a model that could be used to develop such guidelines. This approach uses work/rest information and starting times for a particular assignment as the basic criteria. The authors have developed a software program to automate some of the decision making if desired.

4.2.3 Monitoring and Management Component

Someone must be available to discuss issues about fatigue, working irregular hours, and the strategies that pilots can adopt to reduce or alleviate fatigue. The best candidate for this responsibility is someone who has a training, occupational health and safety, or human resource background. The scope of the job involves becoming a resident resource for fatigue management, which includes being trained in FMP monitoring, implementation and training. The individual responsible for the FMP process will ultimately be responsible for the assessment of the program as it continues, and will work with FMP experts to fine-tune the program over time. The individual will need to have training in counselling procedures such as interviewing, assessment, and monitoring techniques. This person can be referred to as the FMP co-ordinator. The FMP co-ordinator must be able to work with the pilots to resolve fatigue issues and must be impartial to both management and the pilots in order to maintain trust on both sides. The FMP co-ordinator may be a consultant who is retained on a contract to provide counselling services, disseminate fatigue management information, do the fatigue management training, and do the FMP evaluation.

4.2.4 FMP Evaluation Component

The evaluation of the FMP, once it is established, will allow the FMP co-ordinator to determine whether the program is achieving its goals and where the program may need improvement or change. This component is extremely important for justifying the continuation of the program and for keeping everyone informed and aware of the FMP process. This awareness itself will contribute to the success of the program. Pilots and management will provide data to the FMP co-ordinator during the evaluation process and will need to review their own participation in the program. This will heighten awareness of fatigue issues and will likely sensitize participants to the value of reducing fatigue in their day-to-day operations.

4.3 Description of the FMP Components

The fatigue management program includes the following components:

- sleep and fatigue awareness training for pilots;
- proposed guidelines for scheduling assignments;
- guidelines for FMP implementation (support resources, process, responsibilities, etc.); and
- an FMP evaluation process.

4.3.1 Training Modules

The training modules consist of the following sub-components:

- a comprehensive two-day FMP co-ordinator (train-the-trainer) workshop that combines the pilot and management sub-components, and provides lesson plans and the suggested training approaches; and
- a six-hour workshop for pilots that focuses on sleep, circadian rhythms, fatigue, and coping strategies.

4.3.1.1 FMP Co-ordinator (Train-the-Trainer) Workshop

The FMP co-ordinator must take the two day train-the-trainer workshop, which prepares him or her to conduct the six-hour pilots' workshop, to implement the FMP, and to conduct counselling, refresher training, and FMP evaluations. Topics of the train-the-trainer workshop include:

- background on sleep and fatigue management research
- specific scientifically-based information on:
  - sleep
  - biological rhythms
  - fatigue
  - impact of irregular hours of work on the body, health and performance
  - effectiveness of coping strategies
  - future investigations

- techniques for conducting:
  - the six-hour pilots' fatigue management workshop
  - a one-hour fatigue management refresher workshop
- guidelines for the implementation and management of the FMP:
  - planning techniques
  - dissemination of information (newsletters, lunch and learn sessions by FMP participants, monthly posters about fatigue, sleep, etc.)
  - counselling techniques
  - collecting data on FMP effectiveness

4.3.1.2 Pilot Workshop

This intensive six-hour workshop provides information and allows marine pilots to share experiences. Participation is encouraged and suggestions noted. The workshop is a forum to learn about the physiology of sleep, circadian rhythms, coping strategies, and the nature and impact of fatigue on performance. The main topics for the workshop are:

- nature and structure of sleep;
- biological rhythms and their effects;
- causes and impact of fatigue;
- coping strategies; and
- responsibilities in the FMP process.

The pilot's FMP Guide will be sent to each pilot prior to the workshop so that they may familiarize themselves with the material and complete many of the short self-test questionnaires. The self-test exercises are useful for raising awareness and to prepare the pilot for the workshop interaction format. Pilots are expected to share their own experiences and provide opinions about which strategies work and do not work, and why.

Nature and Structure of Sleep

Background information about the physiology of sleep is presented. Participants are encouraged to share their own experiences and to ask questions. Only basic information is covered. Specific topics include:

- sleep stages;
- sleep cycle;
- impact of age on sleep; and
- sleep disorders.

Biological Rhythms

The structure of human biological rhythms are covered in this portion of the workshop, providing participants with the information necessary to plan naps and sleep periods, and to understand how these rhythms may affect their performance and sleep. Participants can ask questions and find out information about their biological rhythms. Topics include:

- the body's many biological rhythms;
- influences on body rhythms (Zeitgebers);
- sleep gates and anchor sleep;
- peaks in alertness and forbidden sleep zones; and
- phase types (morning and evening types of people).

Fatigue

This part of the module examines fatigue in the pilotage work environment, recognizing the signs of fatigue, the causes of fatigue, and the impact of fatigue on performance, health, and social interaction. Participants are encouraged to share their experiences with fatigue while on and off the job. Main areas of interest include:

- definition of fatigue (physical and mental);
- nature of fatigue (environmental, operational, individual);
- relationship between irregular work hours and levels of fatigue;
- impact of fatigue on sleep, health and performance; and
- signs of fatigue.

Coping Strategies

Strategies for obtaining better sleep, organizing time, reducing stress, and keeping healthy in a work environment involving irregular work hours are discussed with participants. Strategies specific to the pilotage work environment are discussed and participants have the opportunity to explore practical ways to better cope with their irregular work hours. They also have the opportunity to share their own experiences. Participants deal with the following topics:

- impact of health, age, sleep, and diet on a pilot's ability to cope with fatigue;
- impact of alcohol and caffeine on sleep;
- facts about sleeping pills;
- use of anchor sleep to reduce a sleep debt and maintain work performance;
- use of caffeine and napping for alertness;
- other strategies to stay alert; and
- strategies used by participants.

Responsibilities in the FMP Process

The pilots learn where they fit in the overall FMP process, what they must do to ensure the success of the program, and what is expected of the pilotage authority. The program is primarily for pilots so the implementation of the program is discussed and suggestions for making the program work are encouraged. Specific topics include:

- FMP process;
- responsibilities of the pilots and the pilotage authority;
- what is required to make the program work; and
- what the pilots see as the most important elements for success.

4.3.2 Scheduling Guidelines

4.3.2.1 Approach

A modified approach to developing guidelines for scheduling is based on those originally developed by Fletcher and Dawson (2001) and Dawson and Fletcher (2001). The guidelines do not result in fixed schedules but contain the rationale necessary to make dispatching decisions and staffing decisions. The guidelines address the maximum number of assignments per tour based on the following criteria:

- optimum hours of work and rest for several assignment lengths and timing;
- nature of the assignments in terms of workload and weather conditions;
- guidelines for night work; and
- individual's duty/rest experience in the past seven days.

The scheduling software described in Section 3.2.2 is applied to several sample tours of duty for two or three individuals, and the guidelines applied to determine whether the approach is feasible and effective.

4.3.2.2 FAID Software

The Fatigue Audit InterDyne (FAID) scheduling software developed by Adam Fletcher at the University of South Australia, in conjunction with Drew Dawson, also at the U. of S.A., has been designed to provide a planning tool for creating schedules that meet human as well as operational requirements. The software allows the scheduler to take into account the employee's circadian rhythms, and his/her past levels of sleep opportunities (i.e. rest periods). The software uses the mathematical model developed by Fletcher (1999). The model provides the basis for predicting an employee's likelihood of experiencing dangerous levels of fatigue if faced with working a particular shift. It provides some predictive power to determine fitness for work on an upcoming schedule, based on the individual's past recovery (repayment of sleep debts), and the point in his/her circadian rhythm in which the shift will occur.

Mathematical Model

The model uses the following mathematical relationship (from Fletcher, 1999):

Intuitively, fatigue and recovery functions would be:

Fatigue(x) = Circadian(x) (1)

Recovery(x) = -Scalar x Circadian(x) (2)

where Circadian(x) is the score or measure of how much fatigue accumulates during hour 'x'. Fatigue accumulates differently for different hours of the day; obviously accumulation is greater across the night and early morning hours than across the day and afternoon. The 'Scalar' determines the rate of fatigue discharge compared with the rate of fatigue accumulation. Note that 'Scalar' is a positive number.

Step 1: Workload model

The workload model assumes that fatigue accumulates throughout the day and throughout the week. If the current fatigue level could be given a score based upon what has been worked in the prior seven days, then the following recurrence relation can be derived:

Score(x) = Score(x-1) + Fatigue(x) (if hours 'x' worked)

Score(x) = Score(x-1) + Recovery(x) (otherwise)

With Score(0) = 0 (3)

This means that a person's working times determine the score or fatigue profile. For a standard work week of 9:00 am to 5:00 pm Monday to Friday, with a normal Saturday and Sunday off:

Score(0) = Score(168) = 0 (4)

Equation 4 states that under normal conditions the person working the above shift will return to the same fatigue level at the end of the week as they were at the beginning of the week.

A comparison of different shifts under the 'Workload' model will show the rate at which the body's fatigue is accumulated and the differences in the final fatigue 'Score'.

Step 2: Fatigue model

The scores from the fatigue model do not accumulate in the same way as in the 'Workload' model. Instead a weighted moving average of previous fatigue and recovery scores is used. The calculation of the weights is done independently for the fatigue and for the recovery. The weight for the fatigue is a function of the times and the hours worked in the previous week, and the weight for the recovery is a function of the times and hours of recovery in the previous week.

continued ...

The functions (for fatigue and recovery) were taken as linearly weighted combinations of the worked or the non-worked hours.

Let: W(x) = Fatigue(x) (if hour 'x' worked)

W (x) = 0 (otherwise)

R(x) = - Recovery(x) (if hour 'x' not worked)

R(x) = 0 (otherwise)

Then:

$$\mathrm{FWeight}(x)=(168.W(x)+167.W(x-1)+166.W(x-2)+....+2.W(x-166)+1.W(x\ 167))/168$$

$$\mathrm{RWeight}(x)=(168.R(x)+167.R(x-1)+166.R(x-2)+....+2.R(x-166)+1.R(x-167))/168$$

The score for the particular period is determined simply by multiplying the weight by the fatigue or recovery score for the period.

Score(x) = Fatigue(x) x FWeight(x) (if hours 'x' worked)

Score(x) = Recovery(x) x RWeight(x) (otherwise)

Comparison of Step 1 and Step 2 Outputs

The output profiles of the two steps are quite different in their appearances and characteristics. The 'Workload' model accumulates an intermediate fatigue score. What is of most interest is the highest, lowest and average levels of intermediate fatigue, combined with both the speed of accumulation and the maintenance of levels of fatigue (area under the profile). The 'Fatigue' model concentrates mainly on the levels of fatigue, where they occur, and the relative height of the peaks. Scores can be generated as being less than zero due to the fact that the 'floor' that values saturate is arbitrarily defined.

In summary, the models derived above show two alternate functions for converting work shift patterns into workload and fatigue profiles, each model determining different information about how shift characteristics, combined with human circadian rhythms, influence the performance of the body during work and non-work.

Fletcher suggests that the following factors be considered when interpreting the results of the FAID scheduling output:

- age;
- sleep disorders;
- psycho-social influences;

- automation and motivation;
- forward and backward rotation of the biological clock; and
- alertness enhancing drugs.

Data Inputs

The data input for FAID involves the following information:

- time of day of work and breaks;
- duration of work and breaks;
- work history in preceding seven days; and
- biological limits on recovery sleep.

Other information includes:

- worker ID #;
- worker location;
- start of shift;
- end of shift; and
- risk level of expected work (workload, nature of work, and environmental stress).

Outputs

The outputs from FAID can include:

- peak fatigue levels for each pilot – different scenarios can be run to determine optimum shifts;
- location of each pilot from a particular staging area where a particular ship will be;
- available pilots for a particular ship;
- indication of which assignments are committed and which are to still be allocated;
- progressive accumulated hours of work for each pilot;
- audit trail for 12 months;
- summaries for any period whenever desired;
- peak risk level compared to a target level;
- peak fatigue score achieved during a shift;
- accumulated hourly fatigue score for the shift;
- plots of fatigue levels for each pilot; and
- tabular results for each pilot.

4.3.3 Guidelines for FMP Implementation

Guidelines to help the FMP co-ordinator and pilotage authority management implement the FMP program will be developed. These guidelines must be clear, practical and flexible. Rationale for interpretation and application will be provided in the guidelines.

The guidelines consist of:

- How to set-up a two-year implementation plan;
- Guidelines for determining when to hold training sessions and workshops; and
- Hints on communicating FMP information.

4.3.4 FMP Evaluation Process

The evaluation process for an FMP is described in this section. The FMP must be assessed for its efficacy and practicality. Assessments using questionnaires, interviews, reviews of counselling documentation, feedback during refresher sessions, informal comments provided by pilots and management, and reviews of documentation regarding pilotage performance, system safety and incidents, must be conducted on a scheduled basis.

4.3.4.1 Questionnaires and Interviews

Management and their pilots will be polled after 12 months to determine how well the FMP has been functioning, what changes were made along the way, and what improvements might make the FMP more valid, practical and effective.

4.3.4.2 Counselling Information

The FMP co-ordinator may learn about elements in the FMP process that have problems. This information can be used to highlight those areas that require further study (input for questionnaire or interview development) or that should be changed.

4.3.4.3 Reporting Fatigue-Related Errors and Incidents

Transport Canada can use its existing databases on human error, and can enhance existing data capture techniques used to identify fatigue as a cause. Errors could be reported to a third party reporting centre (e.g., a private agency that maintains a completely confidential database, funded by Transport Canada or the Transportation Safety Board). A standard form could be developed that allows pilots to enter only information pertinent to the nature of the incident and errors that occurred. The form would not require an individual's name, or names of places or other information that would allow the identification of the pilot. The reliance on reasonable identification of circumstances and conditions would suffice. Details about the relationship of the error to fatigue would be requested, as would any information regarding other potential causes. The FMP co-ordinator would have access to summary data on error rates for different types of errors and associated information. Comparisons of the fatigue-related error rates (per ship movements) for pre- and post-FMP implementation would help to show whether the FMP has helped, and by how much.

If it is not feasible to set up an error reporting system, comparisons of fatigue-related incidents, adjusted for ship movements, may still help to determine the FMP's efficacy. However, this information will be less informative.

4.3.5 FMP Implementation

The success of any program hinges on the participation of all of the stakeholders. In the case of an FMP, upper management, line management/supervisors, schedulers, human resource and occupational health and safety professionals, worker associations, and workers must all support the program in order to fully enjoy its benefit. For the marine pilotage this means pilotage authorities, policy makers, management, FMP co-ordinators, dispatchers, pilot associations, and pilots.

The pilotage authorities can learn more about their role and responsibilities regarding FMP implementation in the detailed guidelines provided in Chapter 5. The FMP co-ordinator will learn his/her responsibilities and procedures during the two-day train-the-trainer workshop course. The pilots will become aware of their role and responsibilities in the six-hour workshop.

4.4 Overall FMP Process

The FMP process is shown in Figure 20. The process starts with outside experts training the FMP co-ordinator. Next, the experts help the co-ordinator develop the FMP operating plan. Then the experts help the co-ordinator proceed through the other training sessions into an operational phase, through to the evaluation phase and redevelopment, and then the process will begin again with the co-ordinator carrying on independently. As time passes the program matures and the amount of training, redevelopment and evaluation reduces to a maintenance level.

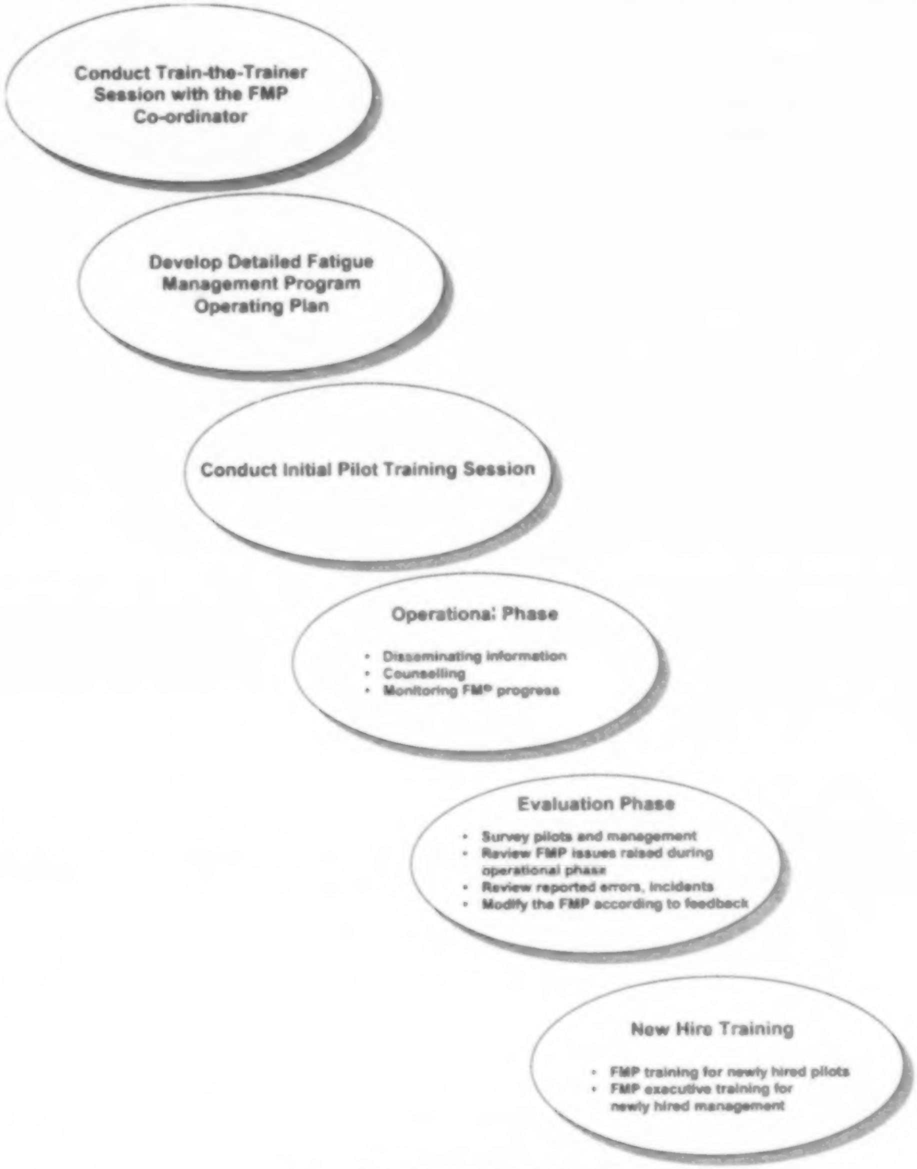
Conduct Train-the-Trainer Session with the FMP Co-ordinator
Develop Detailed Fatigue Management Program Operating Plan
Conduct Initial Pilot Training Session
Operational Phase
• Disseminating information
• Counselling
• Monitoring FMP progress
Evaluation Phase
• Survey pilots and management
• Review FMP issues raised during operational phase
• Review reported errors, incidents
• Modify the FMP according to feedback
New Hire Training
• FMP training for newly hired pilots
• FMP executive training for newly hired management

Figure 20 – Overall FMP Process

5. FMP GUIDELINES

5.1 Purpose

This chapter provides guidelines for **scheduling, monitoring and evaluation**. The scheduling guidelines are designed to be used in conjunction with standard scheduling procedures. They are to be used as a tool at the discretion of the dispatcher, and within the rules of the collective agreements. The monitoring guidelines provide guidance on maintaining contact with the participants in the FMP process, the dissemination of information on fatigue management and the use of feedback for input to the evaluation process. The evaluation guidelines provide a structure for formally assessing the program at the end of each year of implementation.

5.2 Scheduling Guidelines

5.2.1 Purpose

These guidelines are designed to help marine pilot dispatchers direct assignments to the available pilot who is least fatigued. The guidelines take into account when the pilot last worked and for how long, the kind of work conditions that prevailed at the time, and the timing of periods of sleep opportunity. The dispatcher takes the pilot who is at the top of the tour de role and establishes whether the timing of his or her past sleep opportunities and work assignments is acceptable before assigning that individual. The set of guidelines provides an attempt to anticipate the most common situations and provide some insight to be used for those less common situations.

5.2.2 Organization

The guidelines are organized so that they can be selected easily by a dispatcher when confronted with a particular work assignment and pilot. The guidelines are organized as follows:

1. Rationale behind the scheduling guidelines
2. General scheduling guidelines
3. Using a decision tool for scheduling

5.2.3 Rationale

A modified approach to developing guidelines for scheduling is based on those originally developed by Fletcher and Dawson (2001) and Dawson and Fletcher (2001). The guidelines do not result in fixed schedules but contain the rationale necessary to make dispatching and staffing decisions. The guidelines address the maximum number of assignments per tour based on the following criteria:

- optimum hours of work and rest for several assignment lengths and timing;
- nature of the assignments in terms of workload and weather conditions;

- guidelines on night work; and
- individual's duty/rest experience in the past seven days.

During a product trial the scheduling software described in Chapter 4 was applied to several sample tours of duty for two individuals to determine whether the approach is feasible and effective.

5.2.4 General Scheduling Guidelines

The following guidelines can be generally applied.

Before assigning a pilot to a ship:

I. Consider the past work history of the pilot (number of night assignments, lengths of assignments, working conditions of the assignments);

   RATIONALE:
   A pilot who has worked a number of night assignments (>3 in a row), long assignments (>3 at >12 hours), or assignments that have been particularly stressful (ice, severe weather, or extremely high traffic) is more fatigued than a pilot who has not. These kinds of levels of fatigue may compromise safety.

II. Consider the amount of time off between assignments and between tour de role commitments;

   RATIONALE:
   Pilots who have not obtained adequate rest between assignments or tours are more fatigued than those who have had adequate rest. Adequate rest is more likely if there is enough time off to sleep, commute, eat, attend to basic hygiene, and achieve adequate mental and physical recovery.

III. Consider shorter assignments if the ensuing workloads, weather and traffic patterns are expected to be severe;

   RATIONALE:
   If the pilots at the top of the tour de role all have high fatigue levels as indicated by work history, and the ensuing workloads, weather or traffic levels are expected to be severe, reducing assignments to shorter duration (i.e. assigning half-trips if available) reduces the risk of increasing fatigue to debilitating levels.

IV. Consider assigning the most rested pilot at the top of the tour de role for any upcoming assignments that are expected to occur during the night and that are long duration (over 12 hours);

RATIONALE:

Long night assignments require that the pilot be well rested in order to deal with the circadian effects and long duration of sustained attention.

V. Consider assigning the pilot at the top of the role who has had the best opportunity for the most nighttime sleep, providing that the rest period (time off) is adequate (at least 12 hours).

RATIONALE:

A pilot who has had the opportunity to sleep during the night for a natural sleep length functions better than a pilot who has slept during the day for any length of time.

5.2.5 Using a Decision Tool for Scheduling

5.2.5.1 Suggested General Approach

A computer-assisted decision tool helps speed the scheduling process by rapidly calculating the fatigue levels of pilots and their predicted future fatigue levels. The tools accept normal scheduling data such as employee number, predicted or actual start and finish times, and ship name, as well as past work/rest times collected from the past scheduled assignments. If this information is already in a database, the system can be set up to import the information from the database. The computer-assisted tool then performs the necessary calculations and assigns fatigue scores for each pilot at the top of the roll (top two or three pilots, depending on traffic levels). The dispatcher can then review the output and quickly decide who is best fit for the next ship. If that person meets all of the dispatcher's other criteria (expected commute time, pilot's own requests, collective agreement requirements, etc.), then that pilot is called to report for that assignment. If the pilots have a score that is the same, the pilot highest on the roll gets the assignment.

5.2.5.2 FAID Software

The scheduling software developed by Adam Fletcher at the University of South Australia (U. of S.A.), in conjunction with Drew Dawson, also at the U. of S.A., is described in Chapter 4. This software is suited to the marine pilot work environment. Other types of scheduling software may be available and should be investigated for their suitability as well.

5.2.5.3 FAID Software Assessment

The research team assessed the FAID software using a representative set of pilot schedules. The assessment looked at how the product could be used to determine the fatigue levels of the pilots, based on their previous week of work history. The assessment resulted in the following findings:

- The information required is easily accessible from information about the past two weeks' assignments.
- The data can be input into an Excel database that allows easy data management, and later exported to FAID.

- Comparisons of each pilot's estimated fatigue levels can be made based on the work history over the past two weeks.
- Predictions about the pilot's estimated level of fatigue can be made using the "Personal FAID".
- Data for Personal FAID must be input using the Personal FAID input screen, a relatively easy step.
- Dispatchers can use Personal FAID to predict at what level a pilot will be at some given time in the future.
- Both FAID and Personal FAID can be used to make decisions about pilot assignments, taking fatigue into account.
- Outputs of pilot fatigue levels and predicted fatigue levels will allow dispatchers to identify those pilots who may need a few hours of extra rest before being called for a ship.
- Testing of the software should be carried out in a simulated scheduling environment, where pilot assignments can be made in a "close to real" situation, using dispatchers as participant/subjects.

5.3 Monitoring and Sensitization Guidelines

These guidelines provide an outline for monitoring the FMP activities, sensitizing pilotage personnel to the goals and benefits of the FMP, and informally assessing the impact of the FMP on the pilotage system.

5.3.1 Monitoring Activities

The consultant or in-house FMP co-ordinator should carry out the following activities to ensure that the FMP is properly planned and proceeding as planned:

- preparation of a plan;
- informal interviews;
- review of fatigue-related incidents; and
- provide a sounding board for fatigue-related issues.

5.3.2 Sensitization

The following activities should be considered for ensuring that the pilotage authority and its personnel are constantly aware of the FMP, its successes and its goals:

- creation and distribution of a brief quarterly newsletter containing updated information regarding fatigue, articles retrieved from published material (newspapers, magazines, trade journals, etc.) and announcements of FMP related activities (e.g., establishment of new sleeping facilities, upcoming formal FMP evaluation, information sessions);
- posters with reminders about FMP goals, successes, helpful hints on sleep, alertness coping strategies, information on any new facilities (e.g., sleeping room at a pilot house, etc.);

- informal meetings with pilot associations, pilots, dispatchers, pilotage executives and other personnel.

5.3.3 Informal Assessment of the FMP

Problems, successes and progress during the FMP activities should be addressed and monitored. This information can then be used to make changes if necessary (i.e., if the problem causes disruption to the operation), or a recommendation for change can be recorded and used in the formal evaluation and implemented following the evaluation. Successes can be announced and the progress of the program can be communicated to personnel.

5.3.4 Corporate Fatigue Management Program Plan

5.3.4.1 Contents

Purpose

- Inform management of the costs, benefits, and savings of the FMP.
- Help management appreciate the importance of sleep, circadian rhythms and the effects of fatigue.
- Inform managers about their responsibilities and level of support required.

Scope

- Levels of tailoring
- Who is affected

Guiding philosophy

- Managing fatigue involves all parts of the pilotage authority and requires support from all parties.
- Fatigue is potentially dangerous and disruptive, and must be understood and managed effectively.

Outline of FMP components and their relationships

- Education – fatigue management awareness training for pilots
- Scheduling – integration of a scheduling process that includes fatigue management principles
- Monitoring, feedback and communications – establishment of a process of communication, feedback and monitoring (tracking) of FMP activities
- Program evaluation – end-of-year assessment of the program's successes and shortcomings – opportunity to improve FMP

Description of the components

Each component is to be described according to the following criteria:

- purpose;
- description of activities;
- schedule for activities (included in an overall program schedule);
- expected benefits from activities;
- resources required.

FMP responsibilities of the pilots, managers and dispatchers

- Who does what
- Specific outputs and outcomes

One-year, two-year and five-year schedules for FMP activities

- All planned activities presented on a Gantt chart
- Schedule to be sent with the plan to pilots, management and dispatchers, and other interested parties

5.3.4.2 Preparation

The plan should be concise and provide only enough detail to allow efficient implementation of the program. The structure should follow that suggested by the description of content given in Chapter 4. The plan should be updated every year to incorporate changes and new initiatives.

5.4 Evaluation Guidelines

5.4.1 Description

The evaluation of the FMP allows the consultant or pilotage FMP co-ordinator to determine whether the program is achieving its goals, and where the program may need improvement or change. This component is extremely important for justifying the continuation of the program, and keeps everyone informed and aware of the FMP process. This awareness itself will contribute to the success of the program. Pilots and management provide data to the FMP co-ordinator during the evaluation process and need to review their own participation in the program. This heightens awareness of fatigue issues and likely sensitizes participants to the value of reducing fatigue in their day-to-day operations.

The FMP co-ordinator may be someone who is part of the pilotage authority or a pilot association who has the responsibility of training others in fatigue management and who monitors the effectiveness of the program. An outside consultant may be hired to assume these responsibilities. The FMP co-ordinator tracks how the program is proceeding, its perceived effectiveness, actual objective improvement seen by analysis of predicted fatigue levels in pilots, and reductions in reported incidents.

5.4.2 Purpose

The FMP must be assessed for its efficacy and practicality. Assessments using questionnaires, interviews, counselling documentation, informal comments provided by pilots and management, and reviews of documentation regarding pilotage performance, system safety and incidents must be conducted on a scheduled basis. This section lays down the structure in which the evaluation process can be implemented. It contains guidelines for procedures and tools that can be used to collect data and report the level of success and areas of concern after each year of implementation.

5.4.3 Methodology

5.4.3.1 Questionnaires and Interviews

Management and their pilots should be polled after 12 months to determine how well the FMP has been functioning, changes that were made along the way, and improvements that might make the FMP more valid, practical and effective.

Content of Pilot Questionnaire

The questions to be asked should include, but are not limited to:

- Have you applied any of the fatigue reduction and coping strategies described in the training session?
- Which ones did you try?
- How often did you try each strategy?
- Which strategy reduced your fatigue best?
- Which strategy helped you cope with your irregular work hours?
- Was the strategy difficult to apply? Why?
- Did you have to modify the approach to applying the strategy? How?
- Did you try a strategy of your own that was not covered in the training session?
- How well did this strategy work to reduce your fatigue?
- Did you discuss any fatigue reduction strategies with your co-workers? With your family?
- What has been the response of your family to the strategies you chose to apply?
- Do you think that you have been supported adequately in your application of fatigue reduction strategies?
- Where has this support originated? Family? Employer?
- What support has your employer provided that you find the most useful?
- What support from your family has provided you with the best coping and fatigue reduction results?
- Do you feel that the training and information made available to you throughout the year has helped you cope with your irregular hours?

- Has applying fatigue reduction and coping strategies helped you do your job with less stress?
- Has applying fatigue reduction and coping strategies helped you do your job with less work?
- Overall, would you say the application of these strategies has helped improve your job satisfaction?
- Have you been satisfied with the scheduling guidelines?
- Do you feel that the guidelines are fair?
- If not, what aspect do you disagree with?
- Do you feel the guidelines help you avoid working when you are fatigued?
- Can you still work the required number of days?
- What would you suggest should be changed?
- Do you see benefit in continuing the FMP?

Dissemination of Questionnaire

The questionnaires should be mailed to the pilots and completed questionnaires sent back to the consultant or pilotage FMP co-ordinator.

Interviews

The dispatchers and pilotage officials should be interviewed to collect information on how well the FMP has functioned, and to identify any problems that may have occurred during its implementation. The following types of questions will be asked:

Dispatchers

- Have you been satisfied with the scheduling guidelines?
- Have the guidelines helped you improve your scheduling decisions?
- Do the guidelines slow down or speed up your scheduling process?
- What problems have you encountered when applying the scheduling guidelines?
- What would you suggest should be changed?
- Do you see benefit in continuing the FMP?

Managers

- What has been the general impression of the FMP program? Positive/Negative
- What problems, if any, have you encountered with the implementation of the FMP?
- What kind of comments are you getting regarding the program?
- Do you see benefits in continuing the FMP?

Analysis and Reporting

The data from the questionnaires should be entered into a database and the answers to each question summarized. The results will then be compiled in a brief report. The effectiveness of the program and individual strategies will be indicated by the tallies for responses, and should include an assessment of overall satisfaction with the program.

5.4.3.2 Information from Monitoring Activities

The FMP co-ordinator may learn from others in the pilotage authority about elements that have problems in the FMP process. This information can be used to highlight those areas in the process that require further study (input for questionnaire or interview development) or that should be changed.

5.4.3.3 Reporting Fatigue-related Errors and Incidents

Errors could be reported to a third party reporting centre (e.g., a private agency that maintains a completely confidential database, funded by Transport Canada or the Transportation Safety Board). A standard form could be developed that allows the pilot to enter only information pertinent to the nature of the incident and errors that occurred. The form would not require the individual's name or other information that would allow the identification of the pilot. The reliance on reasonable identification of circumstances and conditions would suffice. Details about the relationship of the error to fatigue would be requested, as would any information regarding other potential causes. The FMP co-ordinator would have access to summary data on error rates for different types of errors and associated information. Comparisons of the fatigue-related error rates (per ship movements) pre- and post-FMP implementation would help to show whether the FMP has helped, and by how much.

If it is not feasible to set up an error reporting system, comparisons of fatigue-related incidents adjusted for ship movements may still help to determine the FMP's efficacy. However, this information would be less useful.

5.4.4 Implementation

The evaluation of the program should occur once annually and should involve the pilots, their managers, the dispatchers and the FMP co-ordinator (or consultant). The questionnaires should be distributed to the pilots just prior to the one-year anniversary of the initiation of the FMP. The pilots should have three weeks to respond, returning the confidential questionnaires to the co-ordinator or the consultant. The co-ordinator/consultant will input the data into a spreadsheet or database program. Basic statistics and summaries of responses will be produced, and reported. A discussion of the results should be written, highlighting those areas where improvement is desired, and where the program is successful. Recommended solutions should be suggested by the report, asking for feedback from the recipients of the report. The report should be sent to the pilots, management and the dispatchers.

The co-ordinator or consultant can then determine the feasibility of making changes and can implement those changes that can be made without too much cost. If sizable change is required, the co-ordinator or consultant should prepare a case to be presented to the pilots, management, dispatchers and other interested parties. Feedback at the meeting and subsequent discussion will determine whether the funds are available to make changes, and if they are, a brief plan for implementing the changes can be prepared. When approved by management, they can be implemented. Changes may include such items as changes in emphasis for certain training topics, or changes to the content of the training module. Other changes may involve increased communications among the pilots or between the pilotage authority and the pilots. It may be recognized that refresher training may be a benefit.

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APPENDIX A

DATA COLLECTION TOOLS FOR CHAPTER 3

QUESTIONNAIRE

Fatigue Management Program for Marine Pilots

Dear GLPA Marine Pilots,
As a result of a competitive bidding process, ***Rhodes & Associates Inc.***, a Canadian human factors (ergonomics) consulting firm, was selected by Transport Canada to develop a program for identifying and managing fatigue in marine pilotage. The GLPA has several districts that have operational and geographical elements that may be representative of other pilotages. Hence, the GLPA has offered to help with the development of a prototype Fatigue Management Program (FMP) that will eventually be tailored to each pilotage. The FMP will consist of:

- An educational module dealing with topics such as sleep, circadian rhythms, alertness and sleep strategies, and the impact of fatigue on the human body;
- A set of guidelines to assist in identifying optimal rosters for marine pilots;
- Guidelines for fatigue management support requirements (e.g., adequate sleeping quarters, food for meals, policies regarding napping, etc.); and
- An evaluation tool to track and determine if the program is successful.

Because your input into this initiative is crucial, we are asking every pilot to provide information that will allow us to accurately assess issues related to marine pilots' tasks, the type of environment in which pilots work, and operational conditions pilots typically face. This assessment will help ensure that the FMP is effectively adapted to marine pilot work. You have the opportunity to share your experience and thoughts on these subjects through this **confidential** survey that has been mailed to your home. Please send the completed questionnaire back to us by July 20th, 2001, in the stamped envelope provided, to ensure that the questionnaire arrives at our office in full confidentiality.

Please note that:

- **Your name will not appear on the questionnaire.**
- **Only grouped data and summarized results will be reported.**
- **Only *Rhodes & Associates Inc.* will open and analyse your completed questionnaire.**

We thank you for your assistance with our project and look forward to working with you to develop a useful tool to help improve your health, well-being and quality of life at work and at home.

With regards,

Wayne Rhodes
President
Rhodes & Associates Inc., Human Factors Consultants
177 Jenny Wrenway, Toronto, Ontario M2H 2Z3
Telephone: 416-494-2816 Fax: 416-494-0303
E-mail: wayne-rhodes@home.com

Thank you for your valuable assistance. Completion of this questionnaire is voluntary and all information will remain entirely confidential. As our analysis relies on complete data, please answer as many of the questions as you can. You may, however, skip any questions that you find inappropriate.

Demographic information

1. Gender ☐ M ☐ F

2. What is your highest level of formal education?

   ☐ Secondary ☐ Post-secondary (college or university)
   ☐ Other (please specify): ______________________________

3. What is your age? _____________ years.

4. Do you have children under 18 living at home? ☐ Yes ☐ No

5. Marital status (please select only one):

   ☐ Married/Living with Partner ☐ Single
   ☐ Separated/Divorced ☐ Widowed
   ☐ Remarried

6. How many years have you worked as a marine pilot? ____________ years.

7. What district do you work in?

   ☐ Cornwall ☐ Lake Ontario ☐ District 1 ☐ District 2 ☐ District 3

8. Do you smoke? ☐ Yes ☐ No

   If you answered yes, how many packs do you smoke per day? ________________

9. Do you drink caffeinated beverages? ☐ Yes ☐ No

   If you answered yes, how many cups or drinks do you consume per day? ______

Demographic information

10. Do you accept your assignments wholly according to your collective agreement (e.g., the rules for the *Tour de role*)?

☐ Yes ☐ No

If you answered no, please explain what other criteria are necessary.

11. With respect to fatigue, please describe the worse case assignment you have worked.

12. Are you satisfied with the current dispatch process?

☐ Yes ☐ No

If you answered no, please explain why.

13. How often do you work the following assignments? Please estimate the percentage based on all of your assignments.

Assignments of less than 7 hours	%
Assignments between 7 and 12 hours	%
Assignments longer than 12 hours	%

14. How much time off do you get between the following assignments?

Assignments of less than 7 hours	hours
Assignments between 7 and 12 hours	hours
Assignments longer than 12 hours	hours

15. Thinking about your own experience, please select how much the following industry-specific factors contribute to feelings of tiredness and fatigue.

	Not at all	A little	Quite a bit	Very much
a) Length of time on task				
b) Length of trip				
c) Length of tour of duty				
d) Boredom				
e) Lack of sleep				
f) Weather				
g) Equipment problems				
h) Workload				
i) Sea conditions				
j) Time of day				
k) Crew competency				
l) Onboard sleeping facilities				
m) Crew communication skills				
n) Irregular work hours				
o) Bridge lighting				
p) Bridge ventilation				
q) Bridge temperature				
r) Noise				
s) Other:________________				

Fatigue information

16. What would you like to know about fatigue, sleep, alerting strategies, and the impact of irregular work schedules?

Information about:

☐ Circadian rhythms
☐ Impact of irregular work schedules on health
☐ Sleep disorders
☐ Impact of irregular work schedules on lifestyle
☐ Nature of sleep
☐ Alerting strategies
☐ Nutrition
☐ Other (please specify): ______________________
☐ Coping strategies
☐ Obtaining good sleep
☐ Exercise

17. Please mark on the line below the time of day, at the end of an assignment, when you find you are the most fatigued?

00:00 06:00 12:00 18:00 23:59

18. Please mark on the line below the time of day you find most fatiguing as a start time for an assignment.

00:00 06:00 12:00 18:00 23:59

19. What tasks are the most fatiguing and why?

Task (e.g., interpreting radar information)	**Reason this task is fatiguing**
1.	
2.	
3.	
4.	
5.	
6.	

20. Please list any other factors outside of work (e.g., family, health condition) that may contribute to fatigue.

Factor 1: ____________________

Factor 2: ____________________

Factor 3: ____________________

Factor 4: ____________________

21. Do you take short-calls?

☐ Yes ☐ No

If you answered yes, please estimate how often you take them: _______ /per year.

22. What strategies do you use at home to prepare for work a few hours before your assignment?

☐ Caffeinated drink ☐ Naps before work ☐ Medication
☐ Exercise ☐ Special diet ☐ Relaxation ☐ Bright light
☐ Other (please specify): ____________________

23. What coping strategies do you use to alleviate fatigue during your assignment?

☐ Caffeinated drink ☐ Short nap ☐ Medication
☐ Stretch ☐ Eat ☐ Drink water ☐ Bright light
☐ Other (please specify): ____________________

24. How often do you have to work on your day(s) off between tours of duty?

☐ Never ☐ Rarely ☐ Sometimes ☐ Often ☐ Always

25. How often do you have to work during your holidays?

☐ Never ☐ Rarely ☐ Sometimes ☐ Often ☐ Always

26. Please indicate how much the following are affected by fatigue while working on the bridge during an assignment.

	Not at all	A little	Quite a bit	Very much
a) Decision-making				
b) Simple task				
c) Short-term memory				
d) Long-term memory				
e) Concentration /maintaining attention				
f) Sense of balance				
g) Hand co-ordination				
h) Vision				
i) Feeling weak				
j) Keeping awake				
k) Reading				
l) Communication				
m) Reaction time				
n) Position monitoring				
o) Other: ______________				

27. Please indicate how much the following are affected by call-backs.

	Not at all	A little	Quite a bit	Very much
a) Social/family responsibilities				
b) Health				
c) Performance				
d) Sleep				

Sleep information

28. Generally how well do you sleep at home?

☐ Very Well ☐ Well ☐ Poorly ☐ Very Poorly

29. Do you nap (check as many as apply):

☐ While aboard ship?
☐ Between assignments?
☐ Following most assignments?
☐ Can't nap.
☐ While preparing to do an assignment?
☐ While at home on days off?
☐ Following a particularly tiring shift?
☐ Other (please specify): ____________

30. Please check any of the following that generally prevent you from napping aboard ship.

☐ Poor sleeping quarters
☐ Employer doesn't allow it
☐ Can't nap
☐ Work demands
☐ Competency of ship's crew
☐ Don't believe in napping

31. When is it possible to nap or sleep aboard ship (please check all that apply)?

☐ During lake crossings
☐ While docked and waiting to enter lock
☐ While waiting for your assignment to start
☐ Other (please specify): ____________

____

32. If you nap aboard ship, how well do you sleep, generally?

☐ Very Well ☐ Well ☐ Poorly ☐ Very Poorly

33. While aboard ship, please indicate how often:

	Never	Rarely	Sometimes	Often	Always
a) sleeping facilities are available.					
b) sleeping facilities are adequate.					
c) you use sleeping facilities.					

34. If you use sleeping facilities (if available) at the pilot office(s), how well do you sleep?

☐ Very Well ☐ Well ☐ Poorly ☐ Very Poorly

35. At the pilot office(s), please indicate how often:

	Never	Rarely	Sometimes	Often	Always
a) sleeping facilities are available.					
b) sleeping facilities are adequate.					
c) you use sleeping facilities (if available).					

36. How much sleep do you typically get:

	Hours
a) on your days off?	
b) during the night between assignments?	
c) during the day between assignments?	

37. If you could sleep as much as you wished, how much sleep do you feel is the right amount for you to feel **completely** rested and ready to go?

____________ hours.

38. Which of the following conditions apply to your sleeping environment?

- ☐ Light-tight window coverings
- ☐ Quiet room away from noise
- ☐ Can make trip to bathroom in darkness (e.g., en suite)
- ☐ Use ear plugs
- ☐ Good ventilation with window closed
- ☐ Can control temperature (comfortable)
- ☐ Fan available for ventilation and "white" noise
- ☐ Use sleeping mask
- ☐ Other (please specify): ____

39. Which of the following things, if any, would you find helpful to prepare for sleep?

- ☐ Follow a bedtime routine
- ☐ Read before going to sleep
- ☐ Avoid caffeinated drinks and foods
- ☐ Take sleeping pills
- ☐ Avoid strenuous exercise (running, hockey, soccer, swimming, etc.)
- ☐ Watch TV
- ☐ Have an alcoholic drink
- ☐ Other (please specify): ____

40. How often does most of your assignment fall between 23:00 and 06:00?

____________ % of the time.

41. How often do you have very little sleep (under 5 hours) during longer work assignments?

_____________ Nights per tour of duty.

42. On a typical assignment, do you have time to take breaks?

☐ Yes ☐ No

If you answered yes please specify how often and for how long.

____

43. Do you use cabs or other forms of public transportation to get to and from the location of your assignment?

☐ Yes ☐ No

44. On average, how much time do you usually spend travelling to and from work per assignment (include both public transportation and driving)? ___________ minutes.

45. Please answer the following questions by marking the appropriate box. Note that these questions refer to times when **you** were at the wheel while driving to/from work.

	Never	Once	Twice	3-4 Times	> 4 Times
I have fallen asleep at the wheel driving to/from work.					
I have momentarily nodded off while driving to/from work.					
I have fallen asleep and had an accident while driving to/from work.					
I have momentarily nodded off and had an accident while driving to/from work.					

46. Please indicate your level of agreement or disagreement for each of the following statements.

	Strongly Disagree	Disagree	Agree	Strongly Agree
a) The irregular timing of my assignments makes planning family activities very difficult.				
b) Being on the *Tour de role* hinders my ability to meet family and social obligations.				
c) My sleep is not as restful when I am on the *Tour de role* I.				
d) Tension with family and/or friends occurs when I am on the *Tour de role*.				
e) It is difficult to plan my sleep when on the *Tour de role*.				
f) I think that planning family and social activities for my days off is a successful method to reduce tension.				
g) I feel that while on call I must be creative to accomplish my domestic chores satisfactorily.				
h) Talking with my family and friends about my work helps to reduce tension.				
i) My family resents the fact that I am not able to participate in family activities when I am on the *Tour de role*.				
j) I am able to get adequate exercise when I am on the *Tour de role*.				
k) I am able to maintain regular mealtimes when on the *Tour de role*.				

Thank you for taking the care and time to complete this questionnaire. The valuable information you have provided will help us develop a fatigue management program tailored specifically for marine pilots. Our goal is to ensure that a fatigue management program is a useful tool for marine pilots.

Please note below anything related to your work, sleep, and fatigue level that you feel is important but has not been addressed by this questionnaire.

Marine Pilot FMP Observational Sheet

MP-FMP Observational Sheet

Date: ____________ Page 1 of ____________

Start Time: ____________ Finish Time: ____________

Information about the Vessel

Language: ____________ Fluency: ____________

Ship: ____________ Master: ____________

Type: ____________ Length: ____________

Bridge Layout/Equipment (see attached sketch)

A. Radar: ________ D. Radar: ________ GPS/DGPS: ________ ECDIS: ________

☐ Gyro ☐ VHF ☐ Eng. Rm. Telegr. ☐ Rudder Ind.

☐ Barometer ☐ Eng. Ord. Ep. ☐ Plotting Table

Charts : ____________

Other Equipment

☐ Binoculars ☐ Equip. HBs ☐ Clock

Other: ____________

☐ Sailing Directions ☐ Tide/Current Tables ☐ ROR/LOL

Environmental Conditions

☐ Code of Nav. ☐ Nav. Proc. HB

☐ Shipping Notices Notes: ____________

Lighting:

☐ Dark ☐ Low Light ☐ Medium Light ☐ Bright Light

Noise:

☐ Very Loud	☐ Loud	☐ Medium	☐ Quiet
Can't hear conversation	Difficult to hear	Can converse easily	Can hear whispered conversation

Air Quality: ☐ Good Ventil. ☐ Poor Ventil.

Temperature: ☐ Hot ☐ OK ☐ Cold

Comments: ____________

Sea State: 1 2 3 4 5 6 7 8 9

Precipitation: ☐ Rain ☐ Snow ☐ Sleet ☐ Freezing Rain

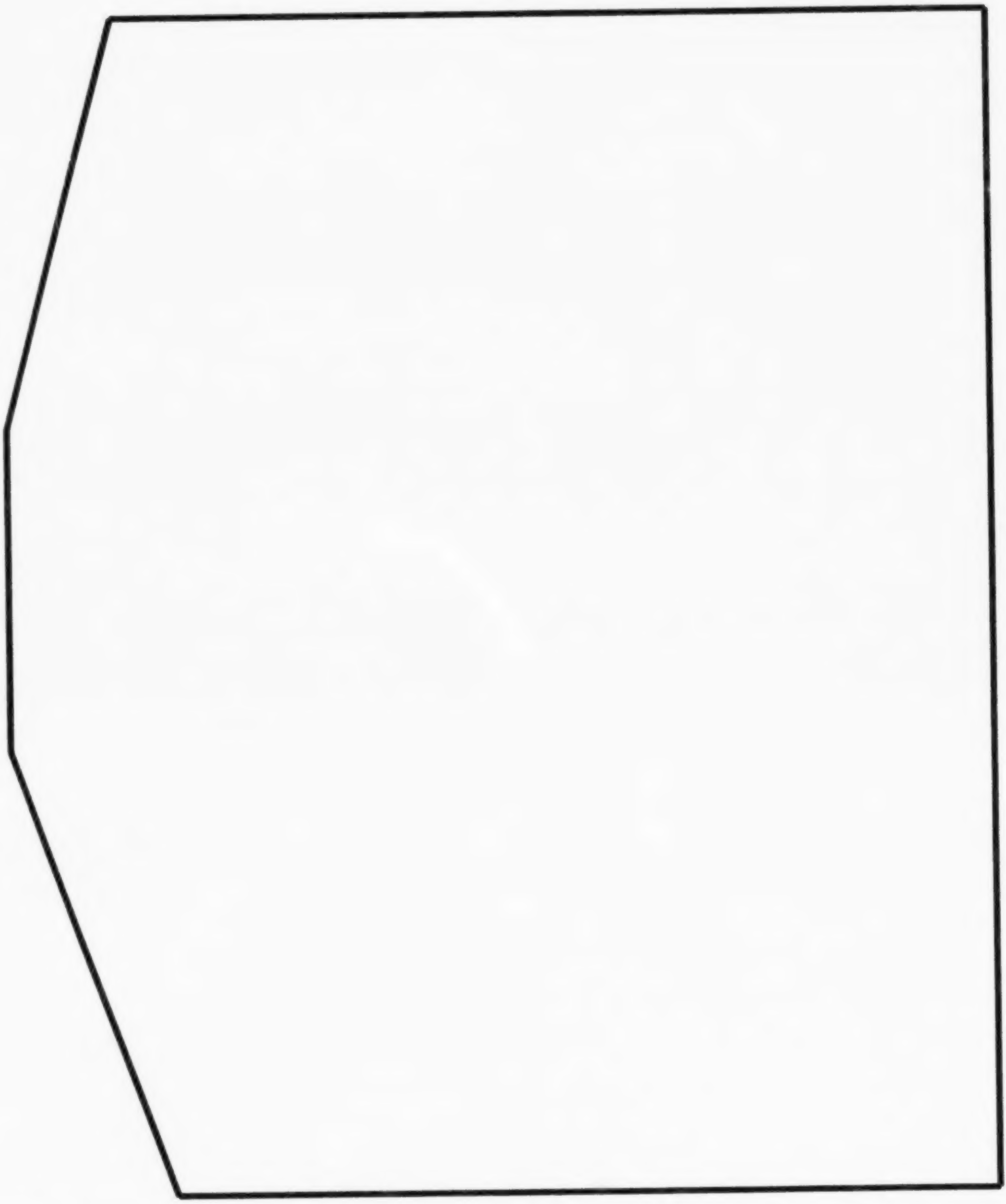
Visibility: ☐ 0-499 m ☐ 500 m ☐ 1 km ☐ > 2 km

B:	1	2	3	4	5	6	7
M:	1	2	3	4	5	6	7

Page 2 of Observational Sheet

Sketch of the Bridge

Page 2 of ____________________



Page 3 of Observational Sheet

Page 1 of ______________________

Task/Elements	**Equip. Involved**	**Personnel Interactions**	**Crit.**	**Comments**

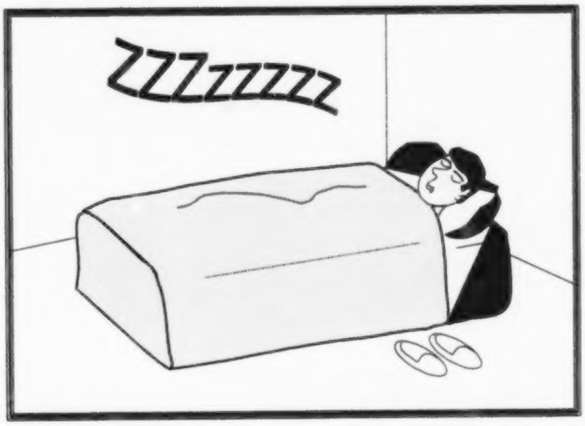
APPENDIX B

SLIDES FOR SIX-HOUR PILOT WORKSHOP

Components of the Workshop

1. Sleep Fundamentals
2. Biological Clock
3. Impact of Irregular Work Shifts
4. Coping Strategies

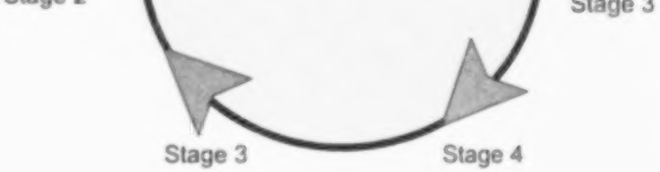
1. Sleep Fundamentals



Sleep Stages

- Non-REM sleep
  - Stage 1
  - Stage 2
  - Stage 3
  - Stage 4
- REM sleep

Sleep Cycle



Stage 1

Stage 2

Stage 3

Stage 4

Stage 3

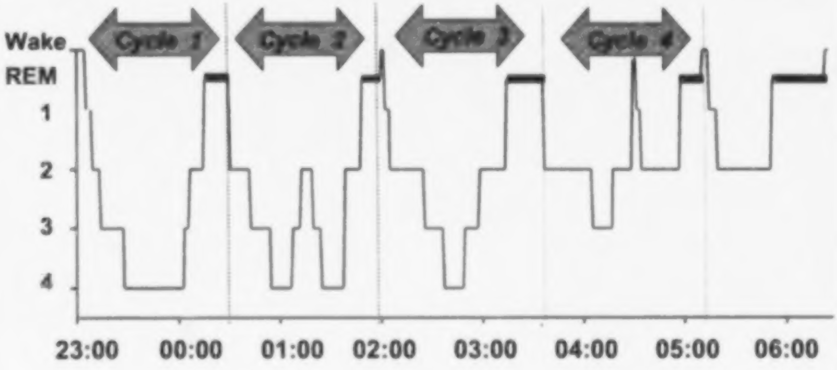
Stage 2

REM Sleep

90 to 120 min

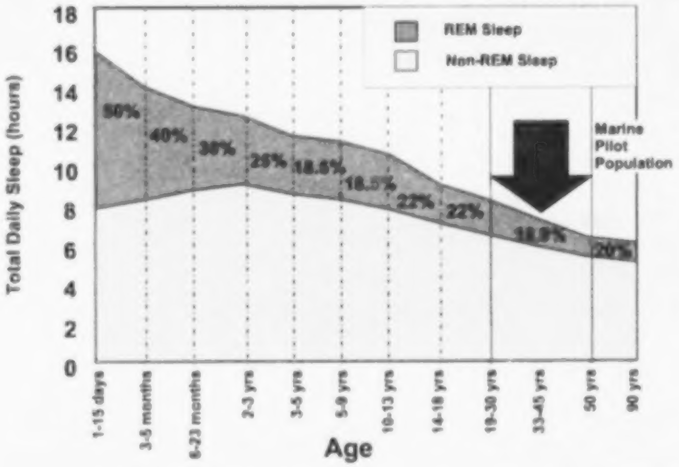
Adapted from *Shifting to Wellness*, Keyano College, 1995.

Hypnogram

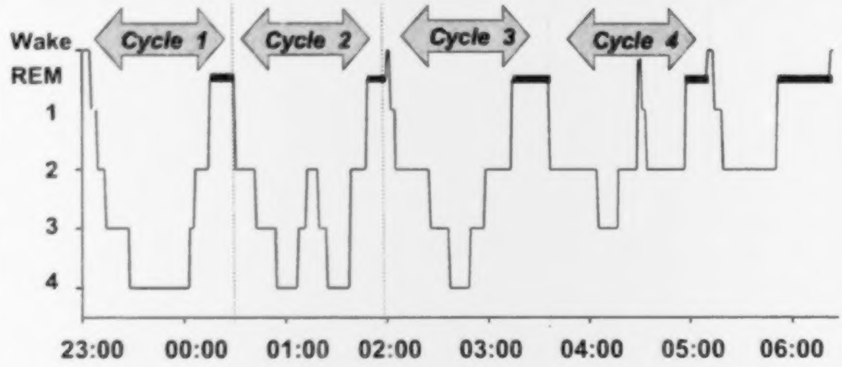


REM sleep is indicated by the heavy bar

Amount of Sleep Obtained by Age

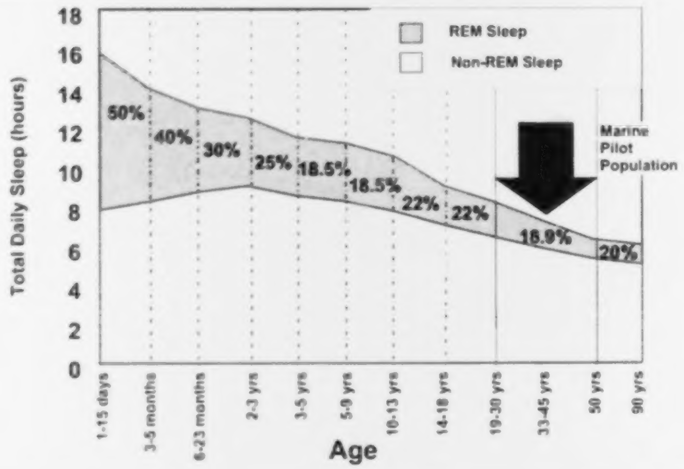


Hypnogram



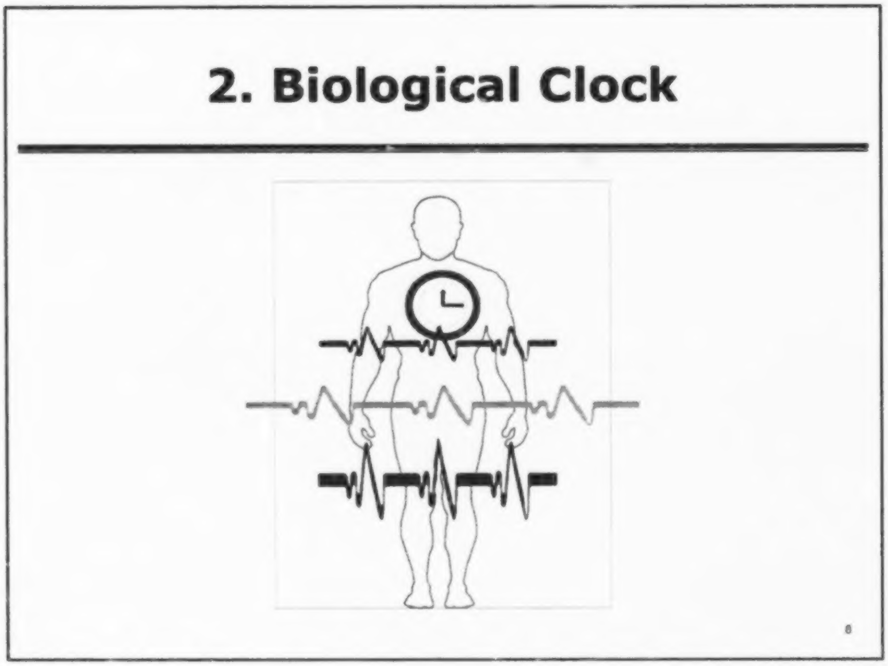
REM sleep is indicated by the heavy bar

Amount of Sleep Obtained by Age



Sleep Disorders

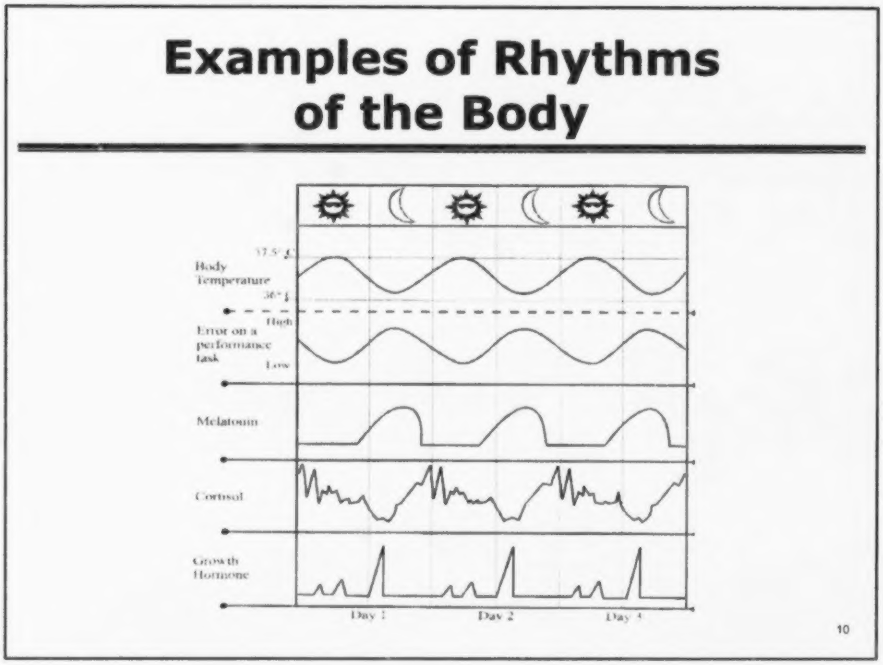
- Insomnia
- Sleep apnea
- Narcolepsy
- Restless legs and periodic limb movement
- Advanced or delayed sleep phase syndrome



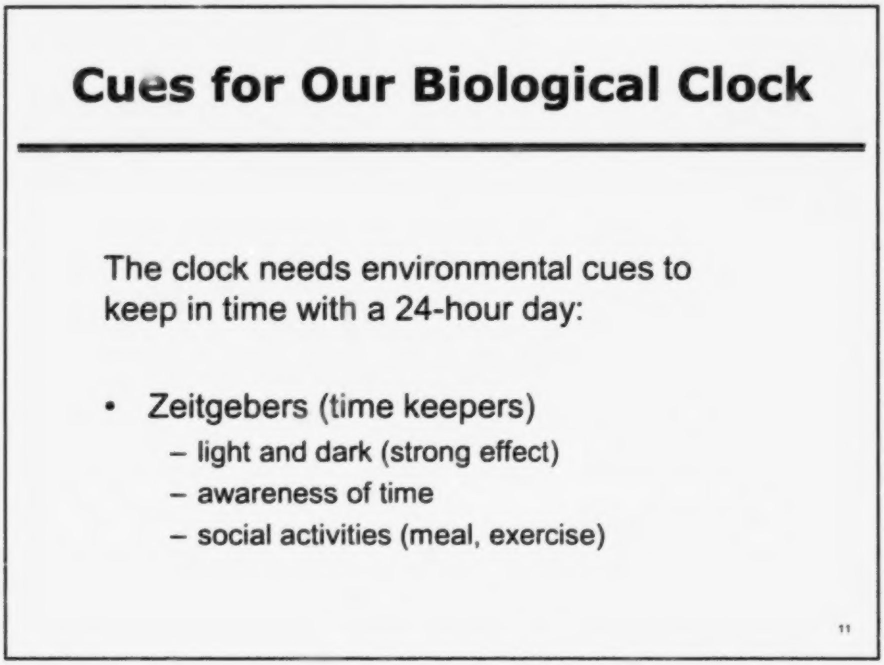
2. Biological Clock

Biological Clock

- The body contains multiple systems that function in cycles
- The duration of the cycles vary: heart rate, temperature, gastrointestinal, reproductive, and sleep/wake
- The clock permits the body to do the right thing efficiently at the right time with some flexibility



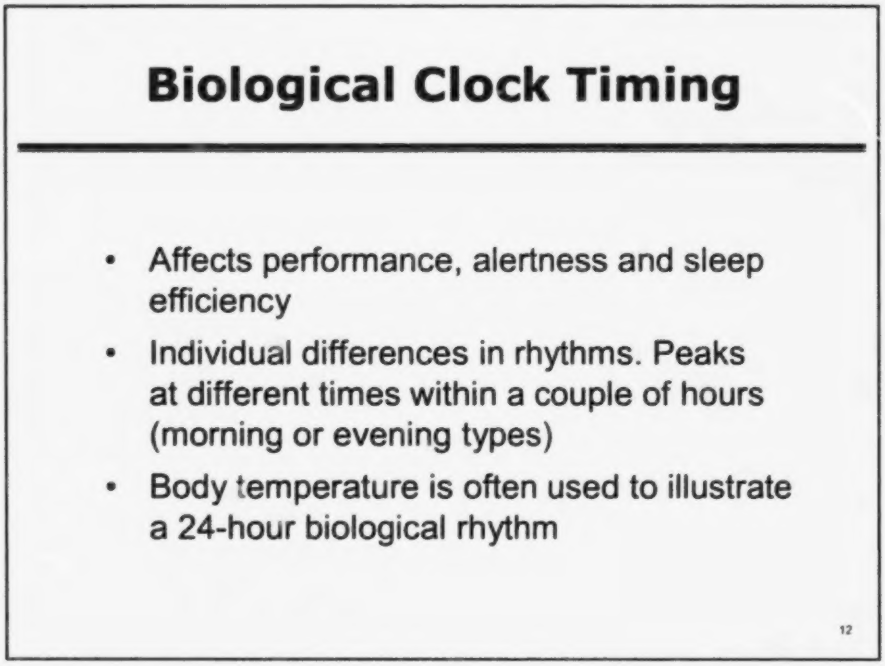
Examples of Rhythms of the Body



Cues for Our Biological Clock

The clock needs environmental cues to keep in time with a 24-hour day:

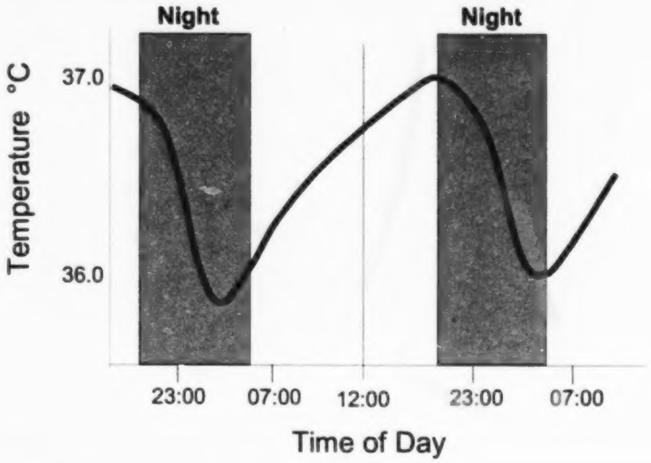
- Zeitgebers (time keepers)
  - light and dark (strong effect)
  - awareness of time
  - social activities (meal, exercise)



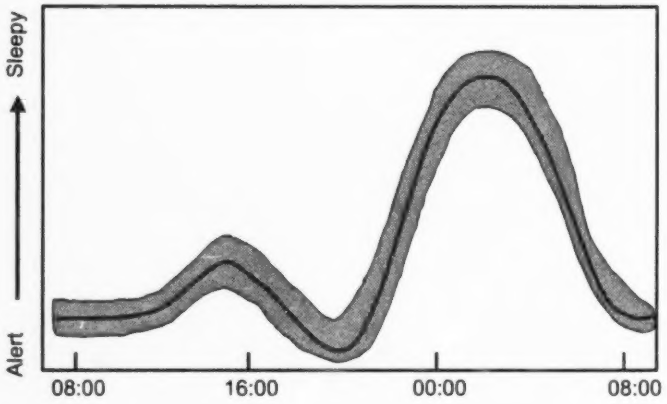
Biological Clock Timing

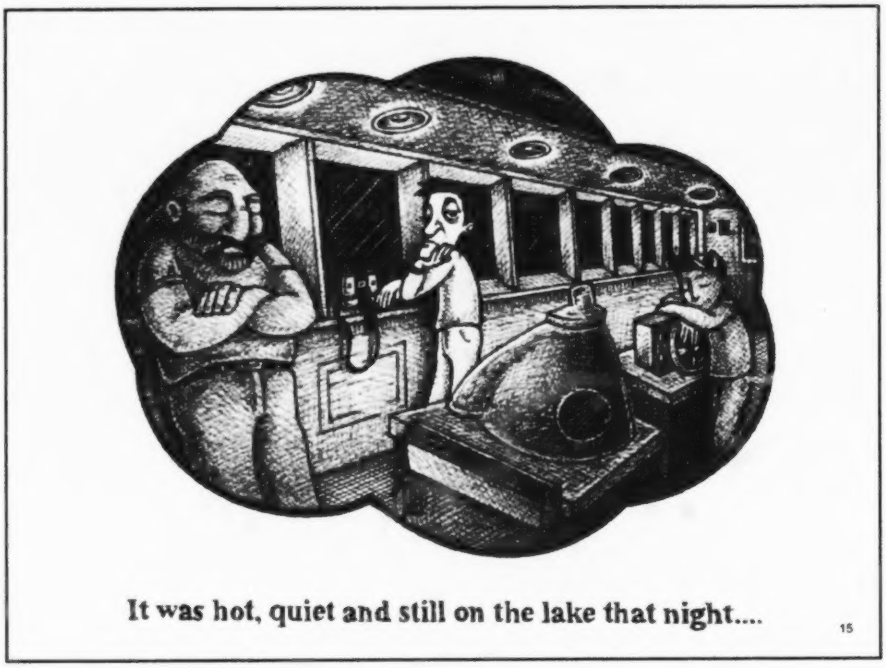
- Affects performance, alertness and sleep efficiency
- Individual differences in rhythms. Peaks at different times within a couple of hours (morning or evening types)
- Body temperature is often used to illustrate a 24-hour biological rhythm

Body Temperature Cycle

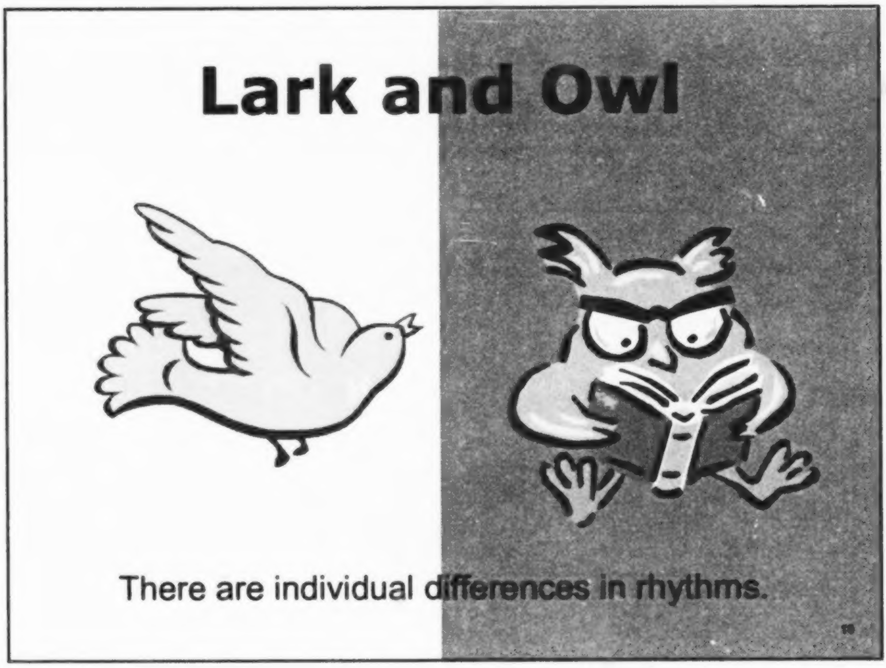


Alertness and Sleepiness Rhythm



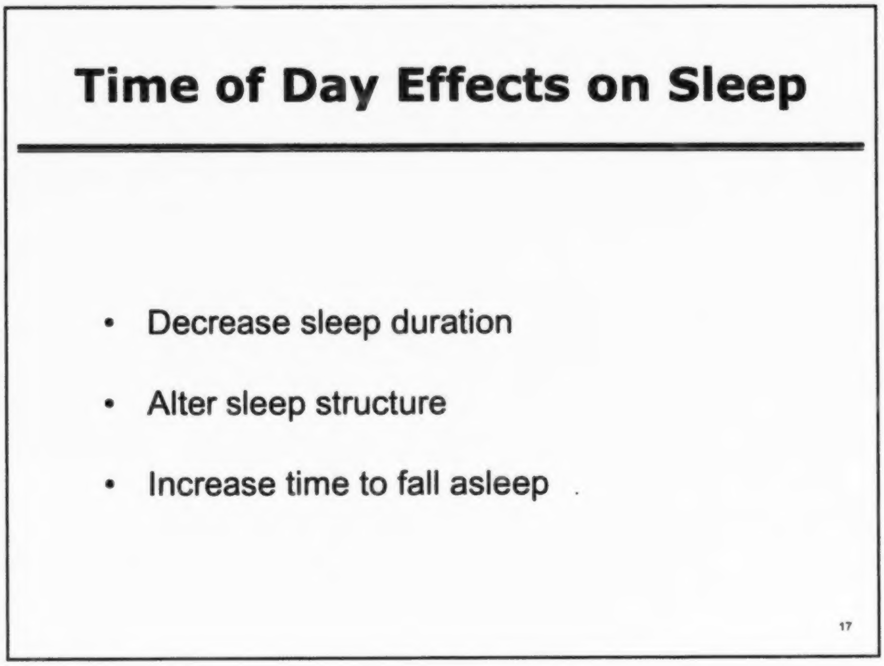


It was hot, quiet and still on the lake that night....



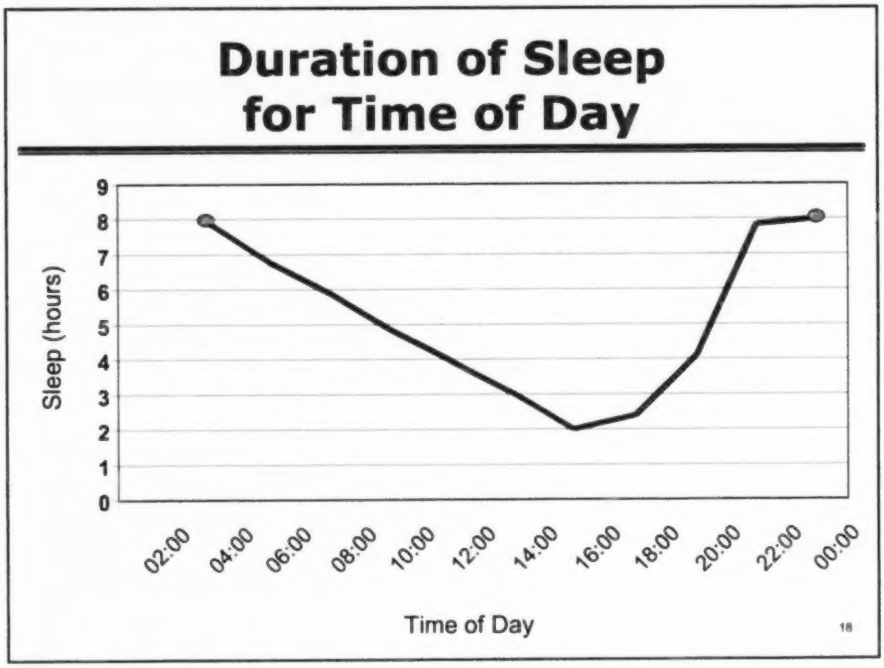
Lark and Owl

There are individual differences in rhythms.

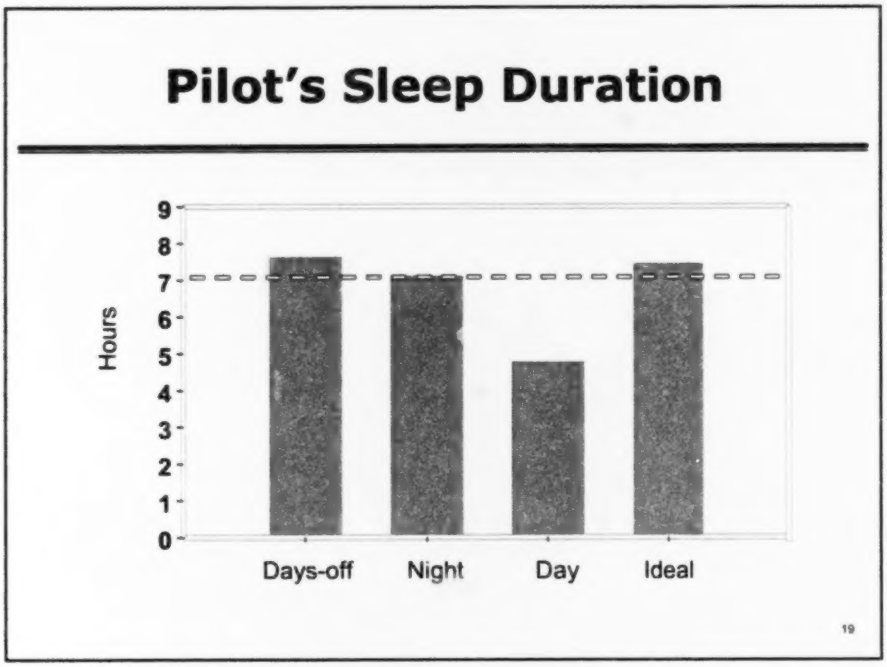


Time of Day Effects on Sleep

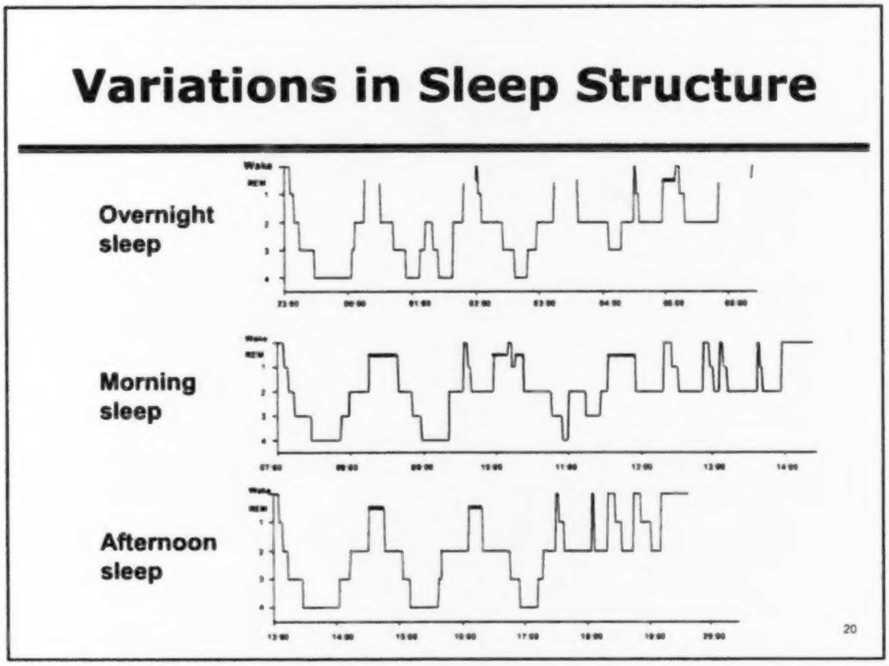
- Decrease sleep duration
- Alter sleep structure
- Increase time to fall asleep



Duration of Sleep for Time of Day



Pilot's Sleep Duration



Variations in Sleep Structure

Overnight sleep

Morning sleep

Afternoon sleep

3. Impact of Irregular Work Shifts

Fatigue & Safety

Performance of sleep-deprived persons is as bad as that of someone who is intoxicated!

- 17 hours awake = a blood alcohol concentration of 0.05%
- 24 hours awake = a blood alcohol concentration of 0.10%

Definition of Fatigue

Fatigue is a **progressive loss of mental and physical alertness that can end in sleep**

- **Physical fatigue** usually occurs after strenuous physical activity or very long periods of activity.
- Lack of sleep and/or sleeping at a different time of the day, or mental stress of high mental workload will quickly result in **mental fatigue**.

Fatigue

Mental Fatigue

(Sleepiness)

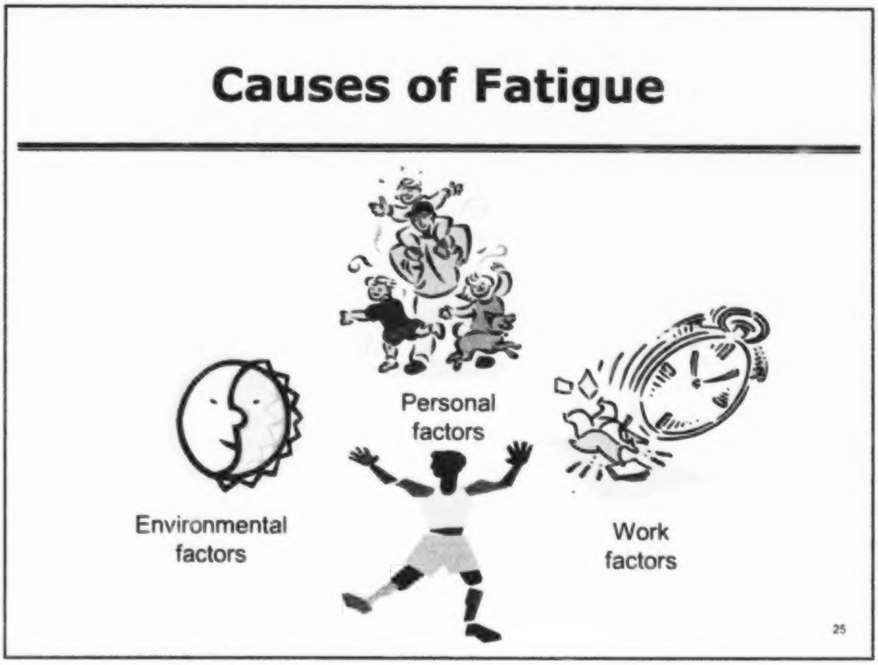
Characterized by:

- Short-term memory loss
- Poor decision making
- Loss of attention
- Night paralysis
- Micro-sleep

Physical Fatigue

Characterized by:

- Reduced strength
- Reduced endurance
- Cramping of muscles, stiffness

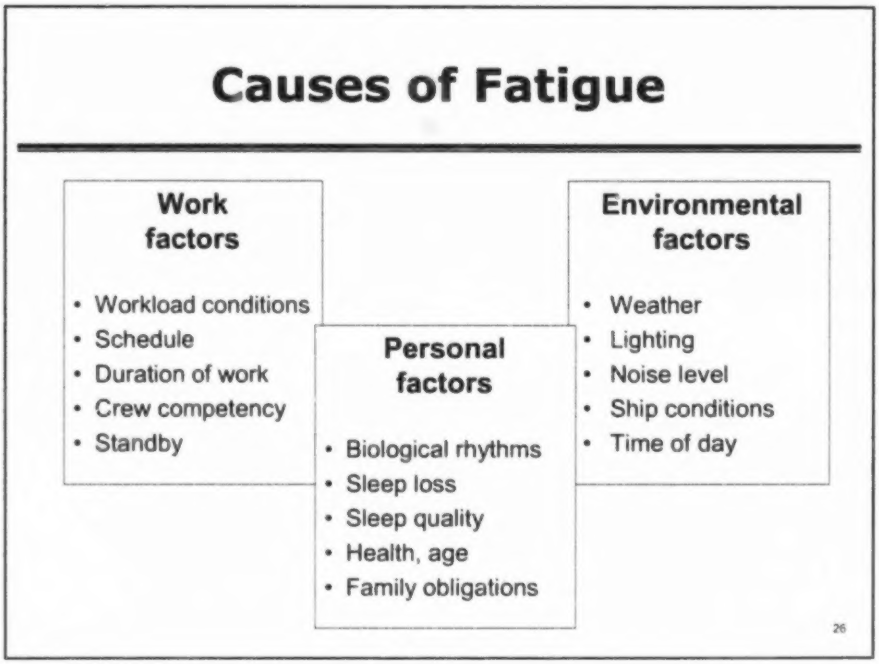


Causes of Fatigue

Personal factors

Environmental factors

Work factors



Causes of Fatigue

Work factors

- Workload conditions
- Schedule
- Duration of work
- Crew competency
- Standby

Personal factors

- Biological rhythms
- Sleep loss
- Sleep quality
- Health, age
- Family obligations

Environmental factors

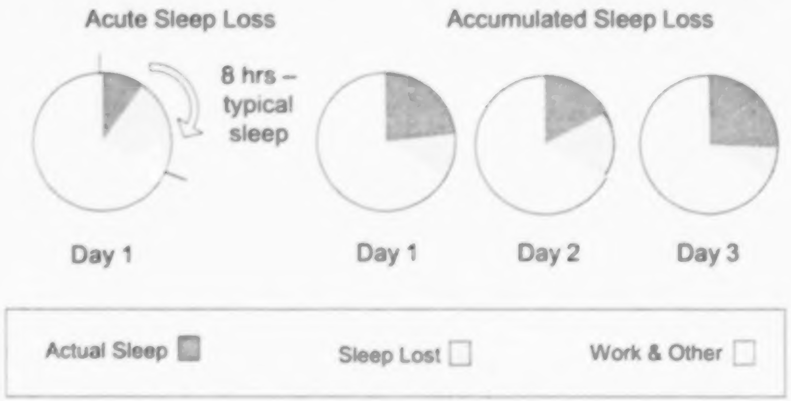
- Weather
- Lighting
- Noise level
- Ship conditions
- Time of day

Signs of Fatigue

- Eyes go out of focus or close for a moment
- Can't stop yawning
- Head nodding
- Wandering and disconnected thoughts
- Blurred vision, seeing mirages ahead
- Drowsy
- Missing reference point, radio calls

- Incorrect reading of equipment
- Forgetting to check position on regular basis
- Giving the wrong command
- Can't remember the last command given
- Reluctant to initiate task and take command
- Inattention to potentially important details
- Forgetting to communicate

Impact of Irregular Work on Sleep



Performance is affected by

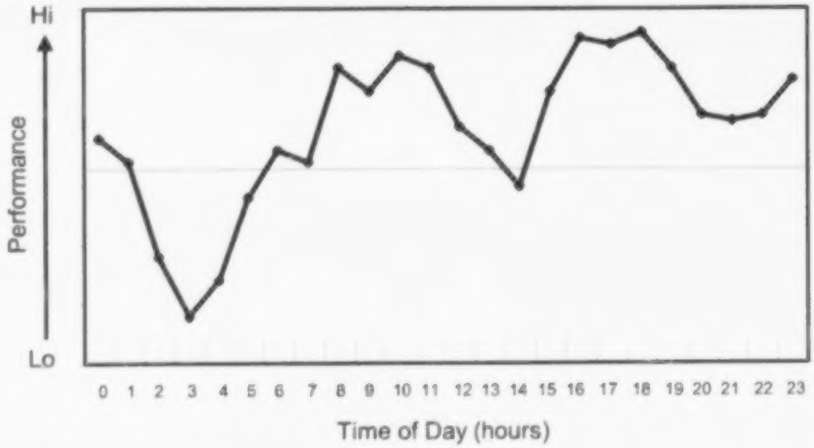
Biological clock

- Performance is significantly degraded during the night
- Performance is somewhat reduced during the afternoon (post-lunch) dip

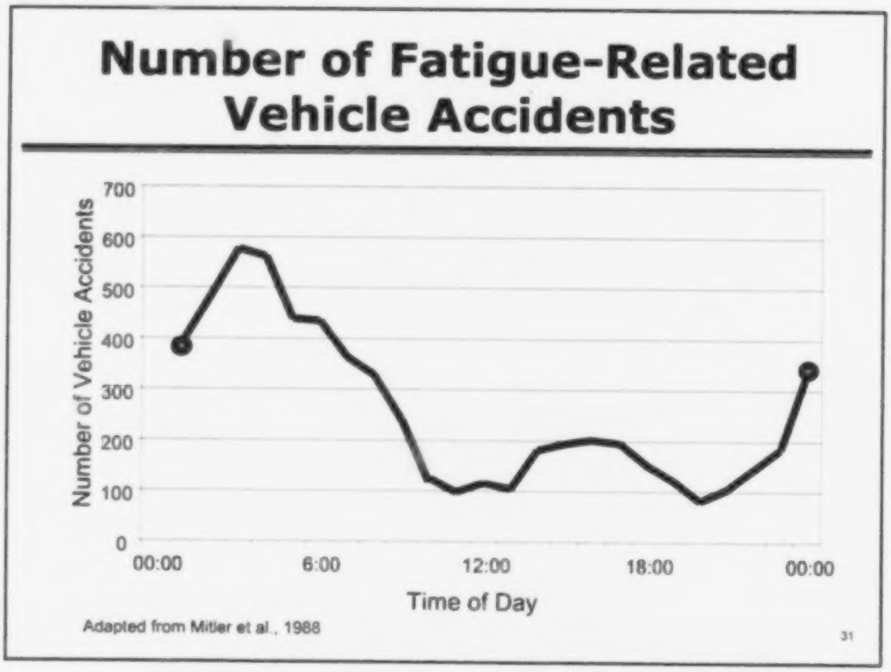
Fatigue

- Performance is degraded with sleep loss (acute or cumulative)

Performance for Time of Day

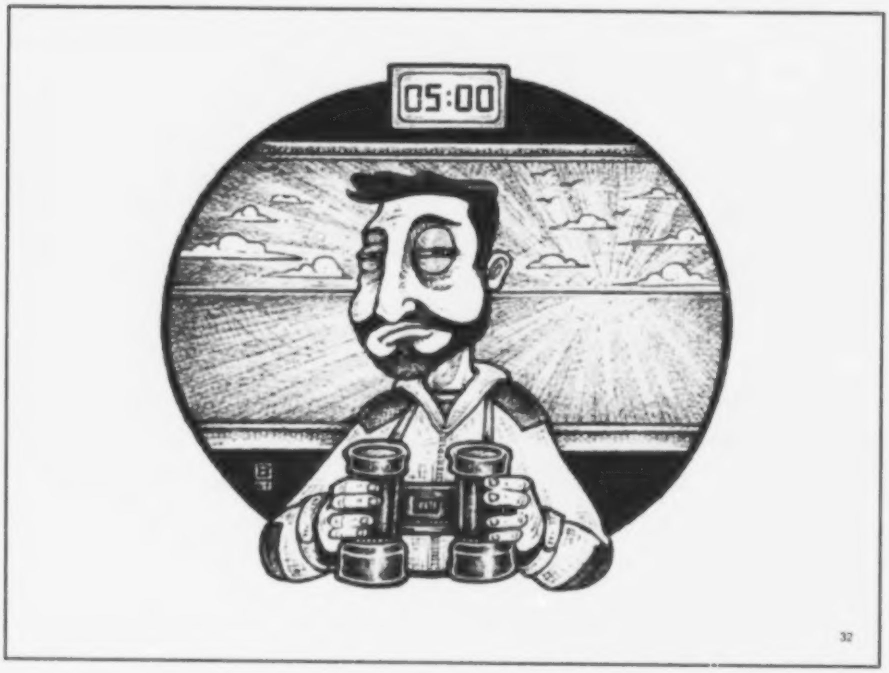


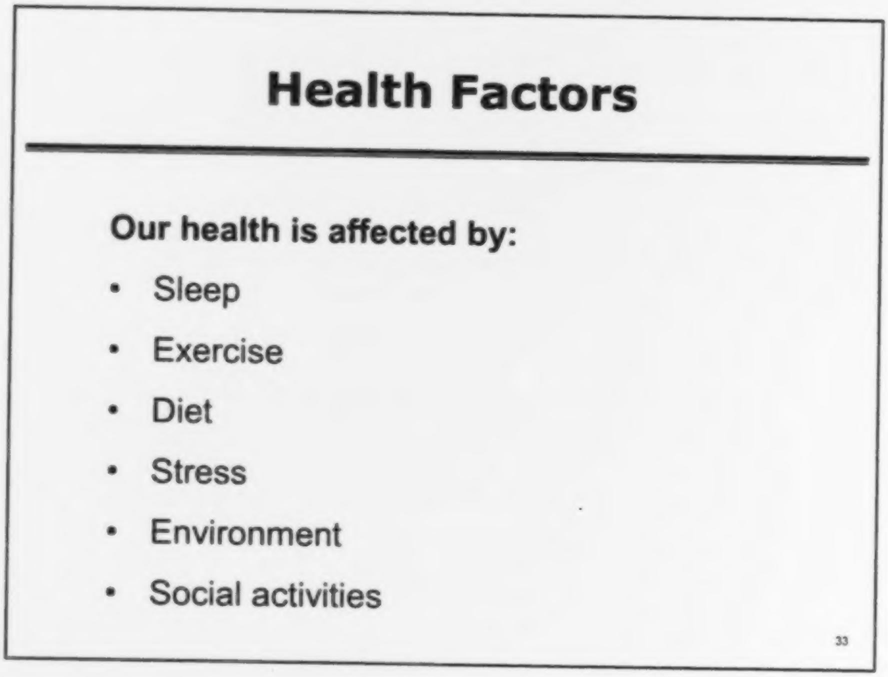
Adapted from Folkard 1996



Number of Fatigue-Related Vehicle Accidents

Adapted from Mitler et al., 1988

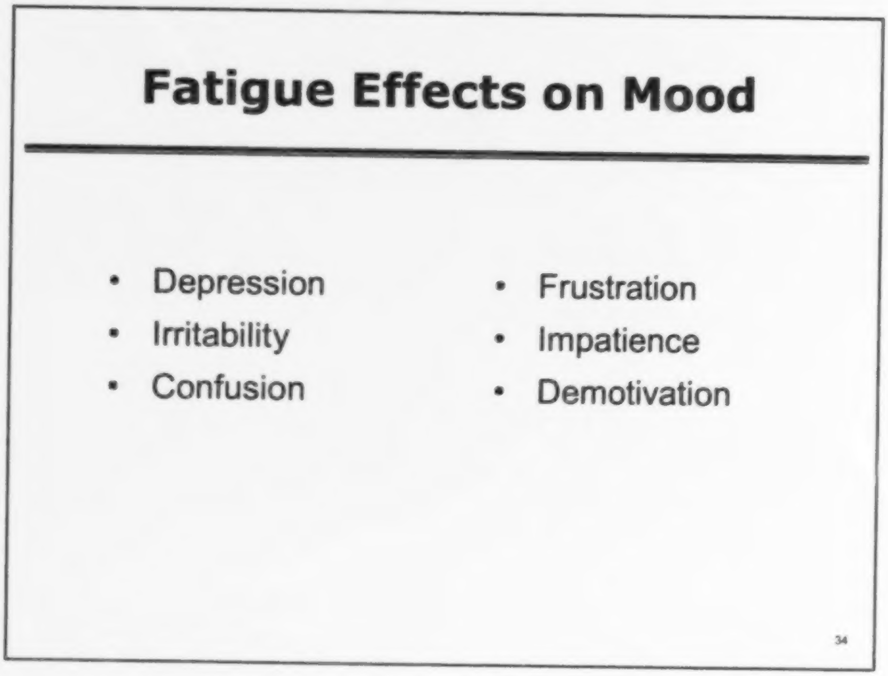




Health Factors

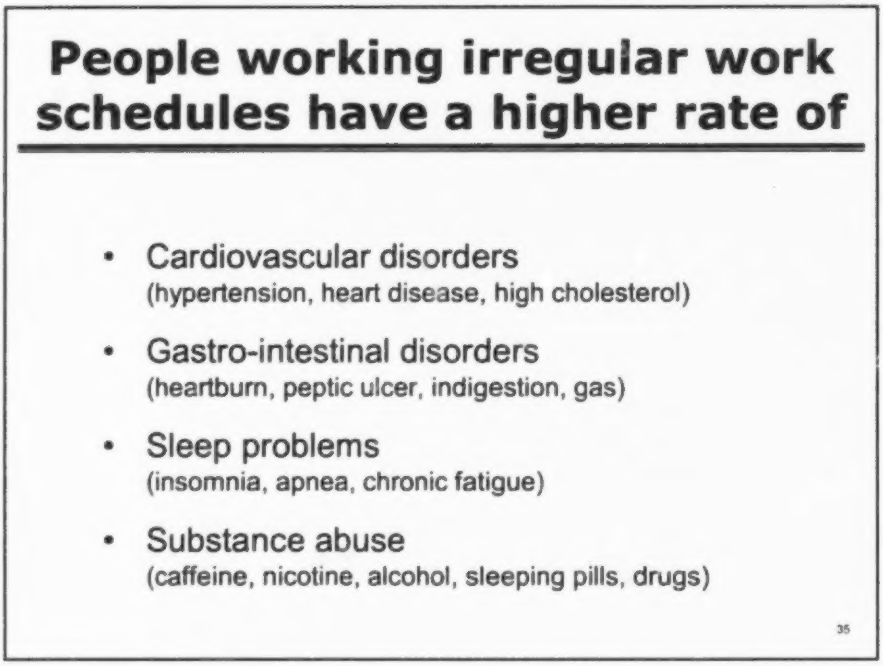
Our health is affected by:

- Sleep
- Exercise
- Diet
- Stress
- Environment
- Social activities



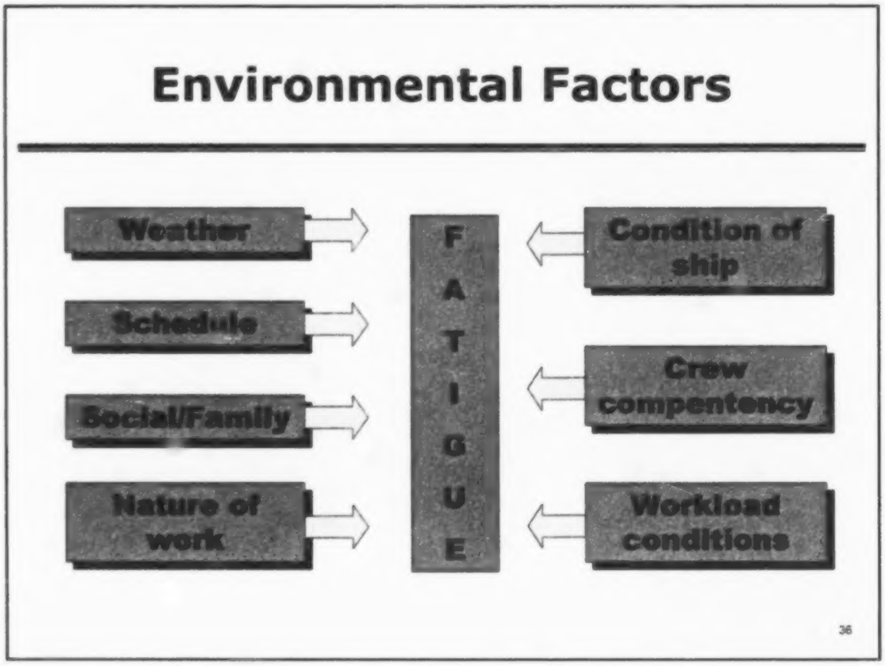
Fatigue Effects on Mood

- Depression
- Irritability
- Confusion
- Frustration
- Impatience
- Demotivation



People working irregular work schedules have a higher rate of

- Cardiovascular disorders
  (hypertension, heart disease, high cholesterol)
- Gastro-intestinal disorders
  (heartburn, peptic ulcer, indigestion, gas)
- Sleep problems
  (insomnia, apnea, chronic fatigue)
- Substance abuse
  (caffeine, nicotine, alcohol, sleeping pills, drugs)



Environmental Factors

Weather

Schedule

Social/Family

Nature of work

FATIGUE

Condition of ship

Crew compentency

Workload conditions

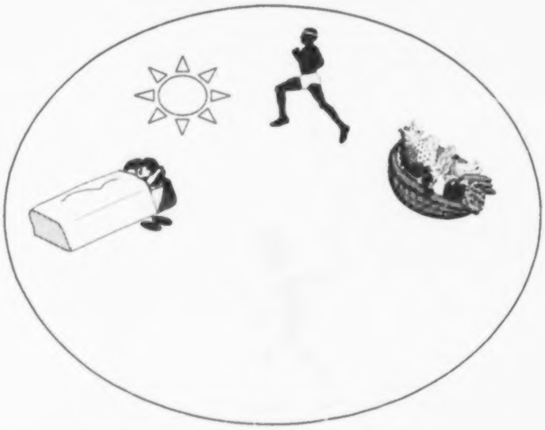
Remember

When we are severely fatigued…

neither motivation,
nor training,
nor professionalism

…can prevent our brains from shutting down
when we desperately need sleep!

4. Coping Strategies



Coping Strategies

Home Strategies

- Sleep environment and practices
- Healthy lifestyle
- Time and stress management

Sleeping Environment

The environment should be:

- Dark
- Well-ventilated
- Quiet
- Comfortable
- Isolated from other activities

Sleep Practices

Do... ☑	**Don't...** ☒
Establish a bedtime routine	Drink too much liquid
Relax	Exercise vigorously before bed
Read	Consume alcohol, nicotine or caffeine before bed (2-4 hrs)
Inspect labels on cold medications	Go to bed hungry
Nap	

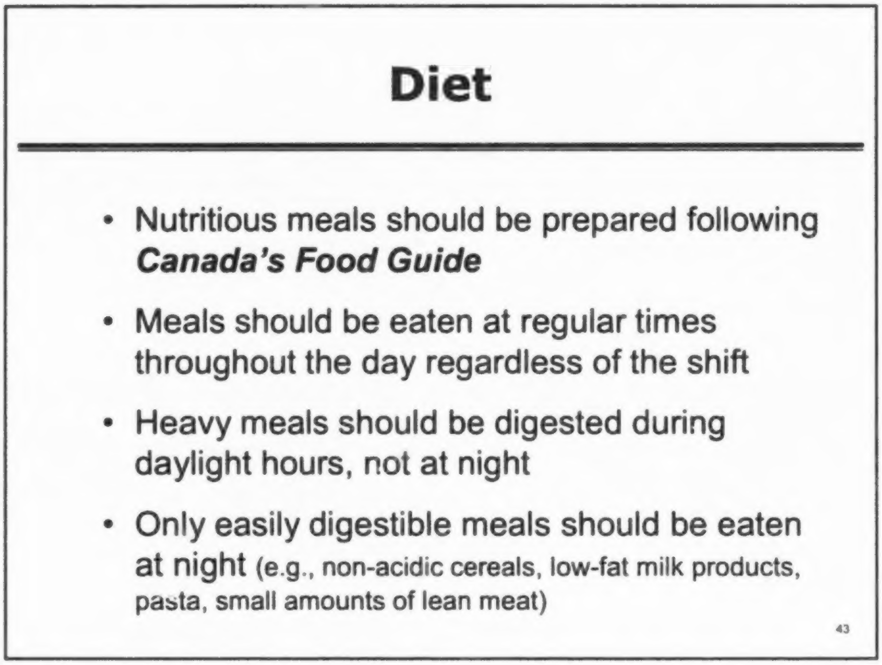
Healthy Lifestyle

Fitness:

Regular exercise will improve your health and increase your ability to tolerate stress

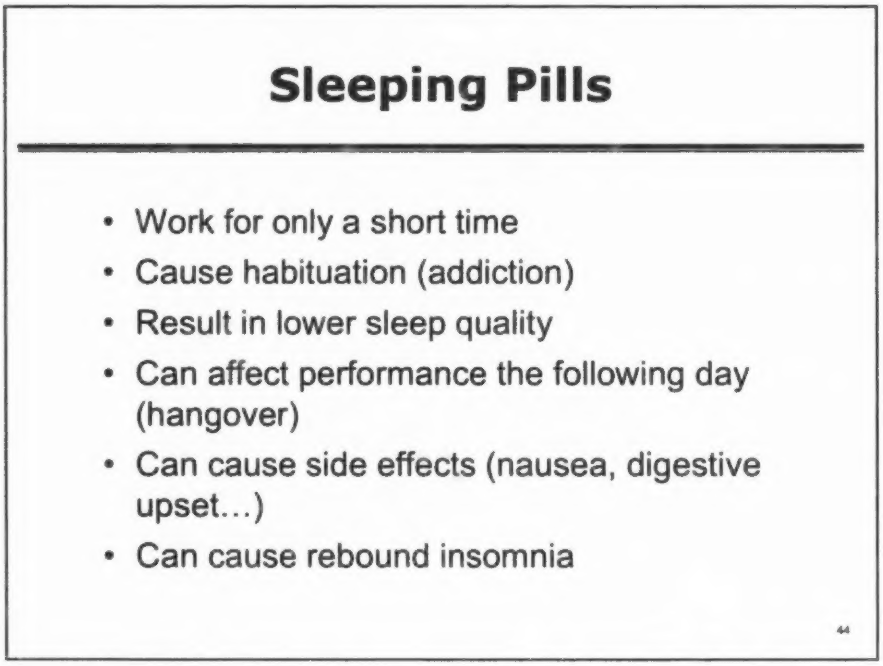
Exercise that can be done for 20 minutes at medium intensity four times a week:

- **Without equipment**:
  push-ups, sit-ups, jumping jacks, stretching…
- **With equipment**:
  treadmill, stationary bike, step machine…



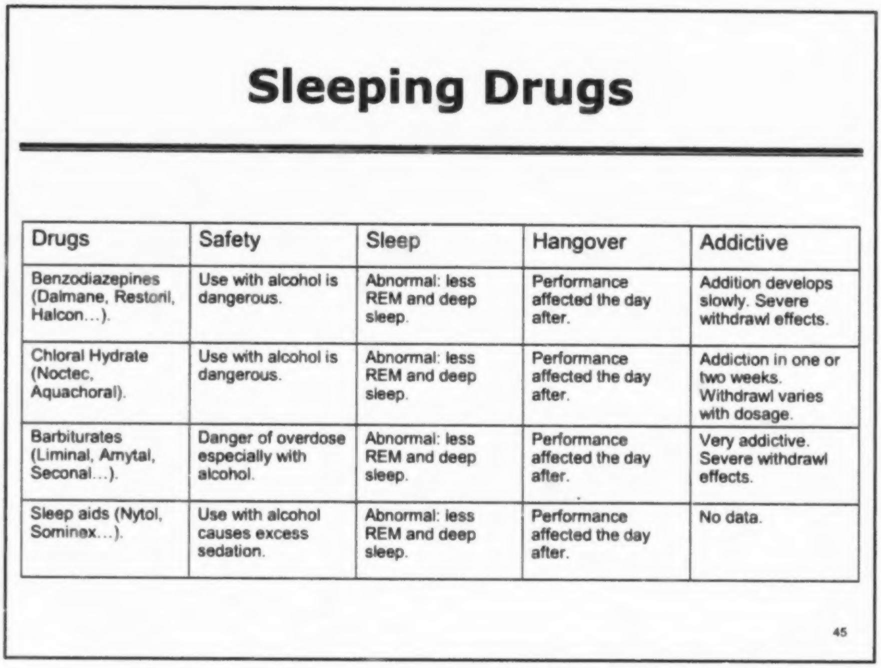
Diet

- Nutritious meals should be prepared following ***Canada's Food Guide***
- Meals should be eaten at regular times throughout the day regardless of the shift
- Heavy meals should be digested during daylight hours, not at night
- Only easily digestible meals should be eaten at night (e.g., non-acidic cereals, low-fat milk products, pasta, small amounts of lean meat)



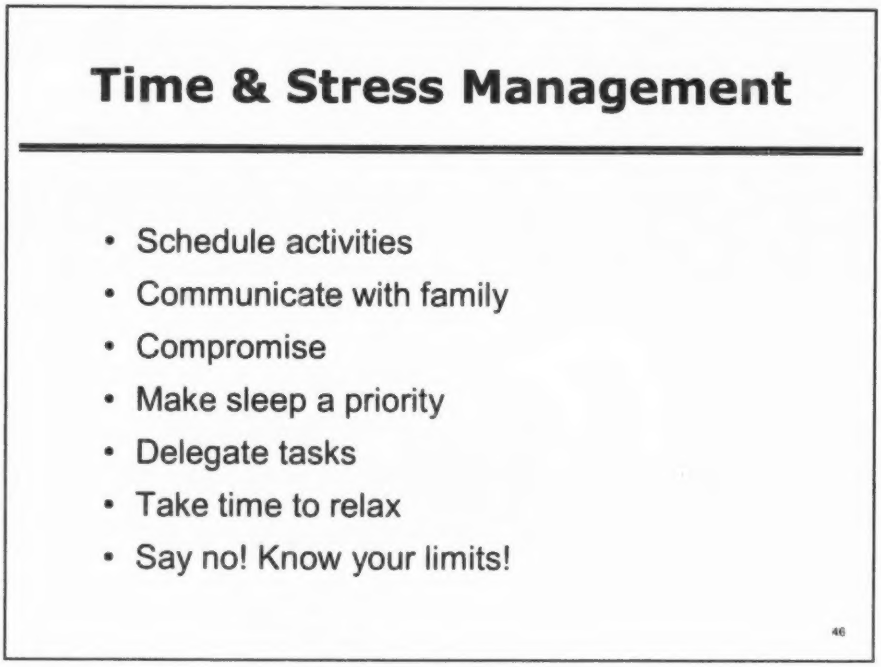
Sleeping Pills

- Work for only a short time
- Cause habituation (addiction)
- Result in lower sleep quality
- Can affect performance the following day (hangover)
- Can cause side effects (nausea, digestive upset…)
- Can cause rebound insomnia



Sleeping Drugs

Drugs	Safety	Sleep	Hangover	Addictive
Benzodiazepines (Dalmane, Restoril, Halcon…).	Use with alcohol is dangerous.	Abnormal: less REM and deep sleep.	Performance affected the day after.	Addition develops slowly. Severe withdrawl effects.
Chloral Hydrate (Noctec, Aquachoral).	Use with alcohol is dangerous.	Abnormal: less REM and deep sleep.	Performance affected the day after.	Addiction in one or two weeks. Withdrawl varies with dosage.
Barbiturates (Liminal, Amytal, Seconal…).	Danger of overdose especially with alcohol.	Abnormal: less REM and deep sleep.	Performance affected the day after.	Very addictive. Severe withdrawl effects.
Sleep aids (Nytol, Sominex…).	Use with alcohol causes excess sedation.	Abnormal: less REM and deep sleep.	Performance affected the day after.	No data.



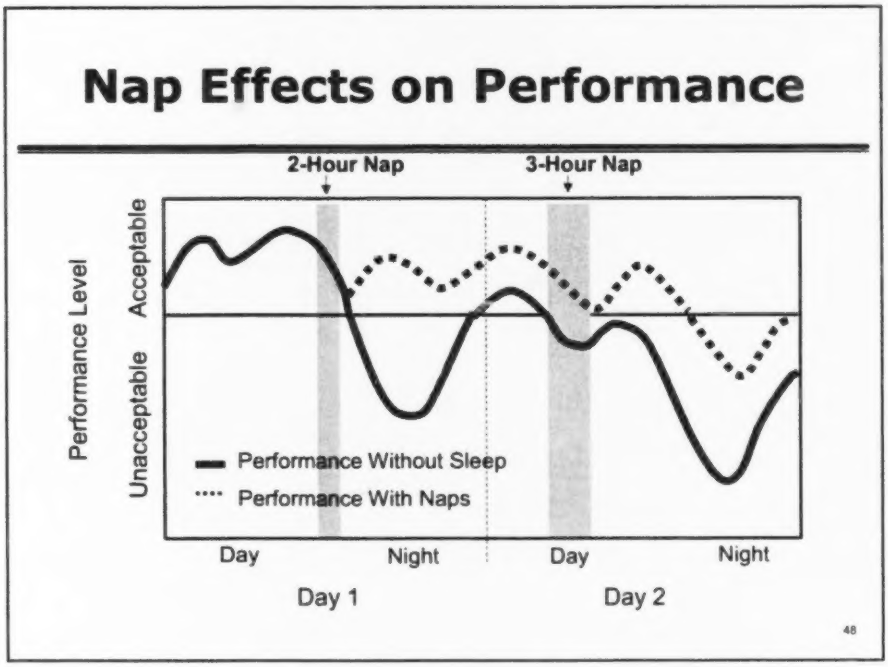
Time & Stress Management

- Schedule activities
- Communicate with family
- Compromise
- Make sleep a priority
- Delegate tasks
- Take time to relax
- Say no! Know your limits!

Coping Strategies

Work strategies

- Napping
- Strategies to stay awake
- Other strategies



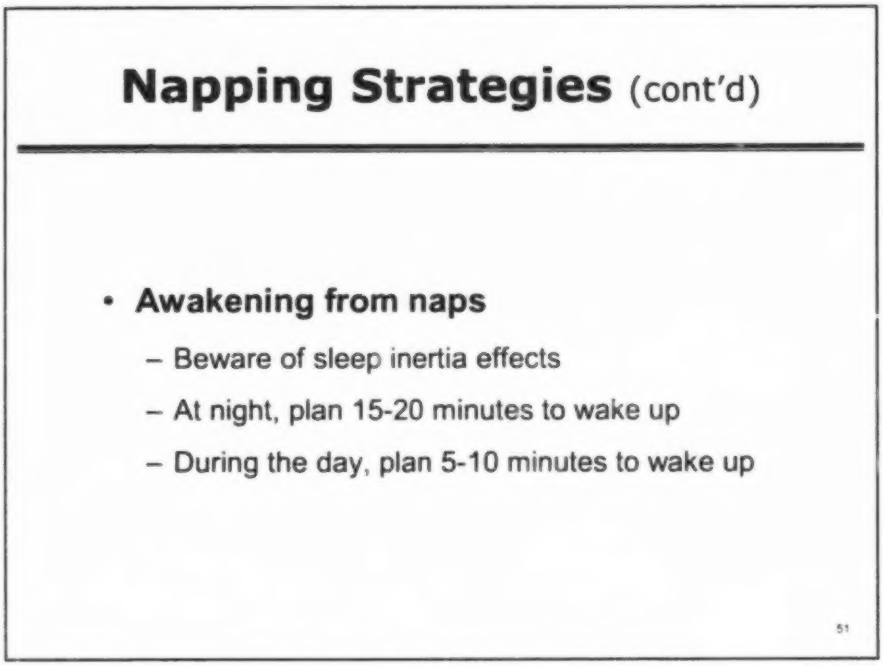
Nap Effects on Performance

Napping Strategies

- **Planning**
  - – Nap prior to sleep loss
  - – If not possible, take opportunistic nap
- **Nap environment**
  - – Napping should be done lying down
  - – If possible, make sure your nap period is worry-free

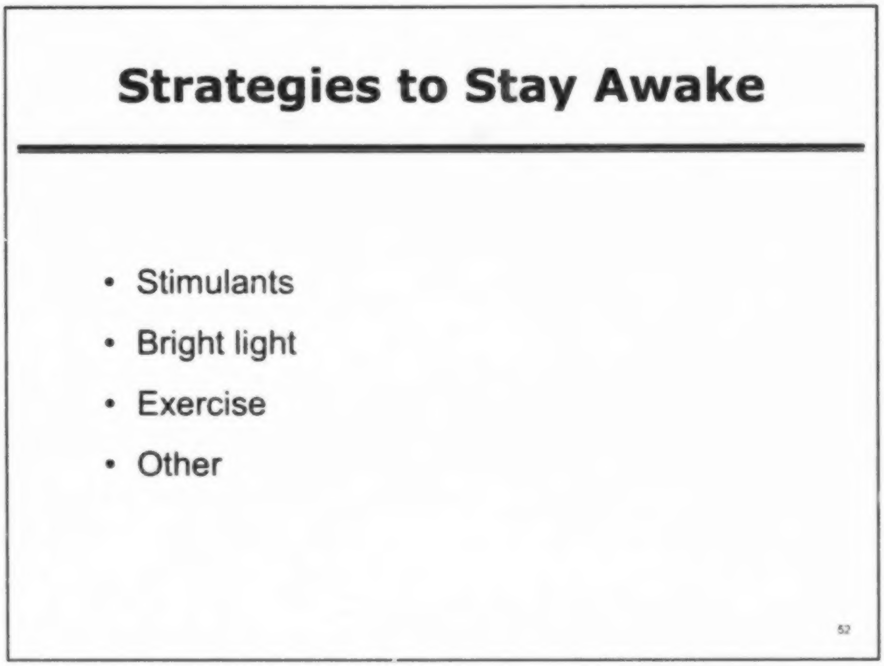
Napping Strategies (cont'd)

- **Nap timing**
  - – Nap when the body is most recpetive to it (night or mid-afternoon)
- **Nap duration**
  - – Nap should be as long as possible if no other sleep period is planned in the next 12 hours
  - – If longer naps are not possible, several 10-40 minute naps can be taken



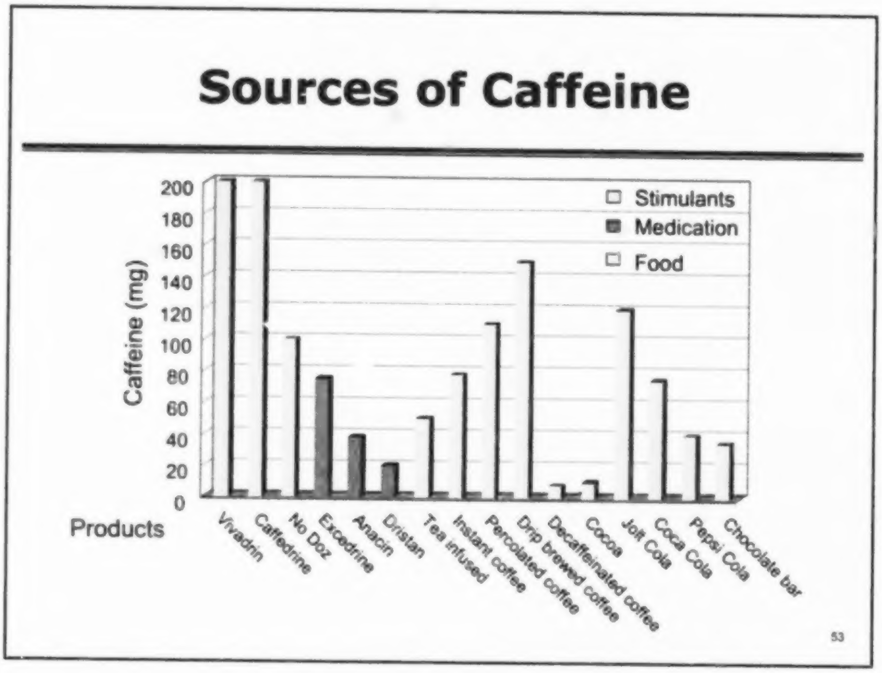
Napping Strategies (cont'd)

- **Awakening from naps**
  - Beware of sleep inertia effects
  - At night, plan 15-20 minutes to wake up
  - During the day, plan 5-10 minutes to wake up

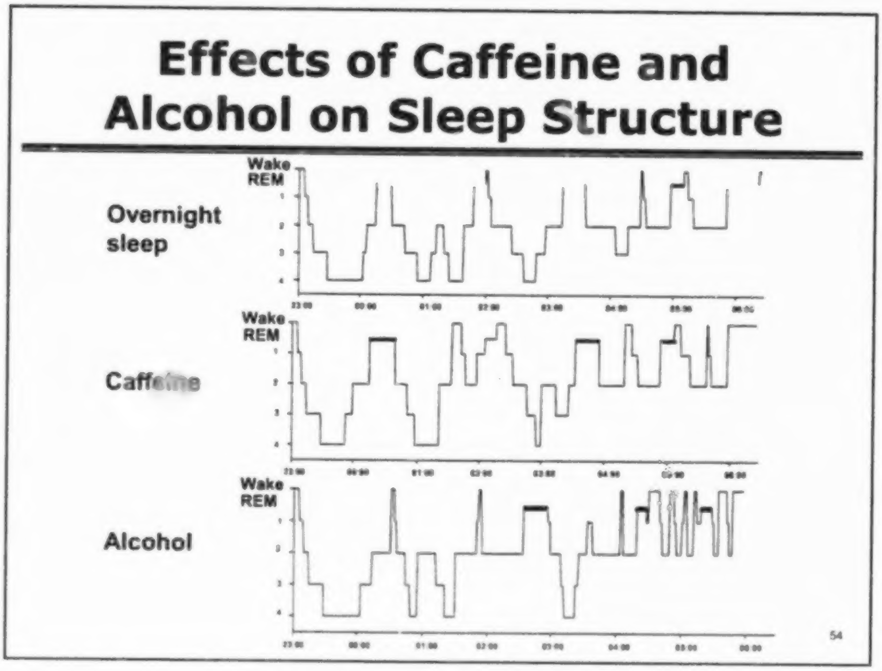


Strategies to Stay Awake

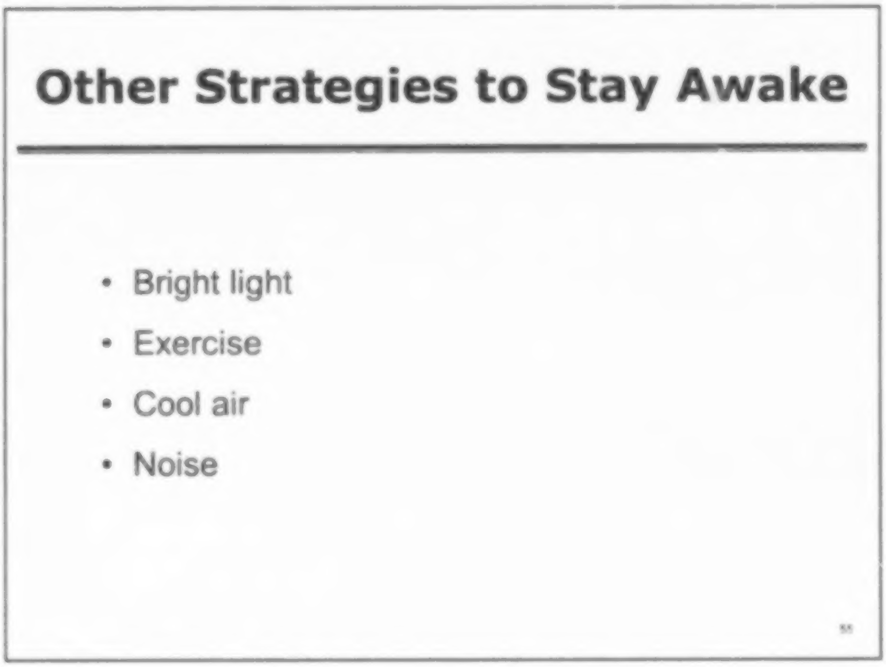
- Stimulants
- Bright light
- Exercise
- Other



Sources of Caffeine

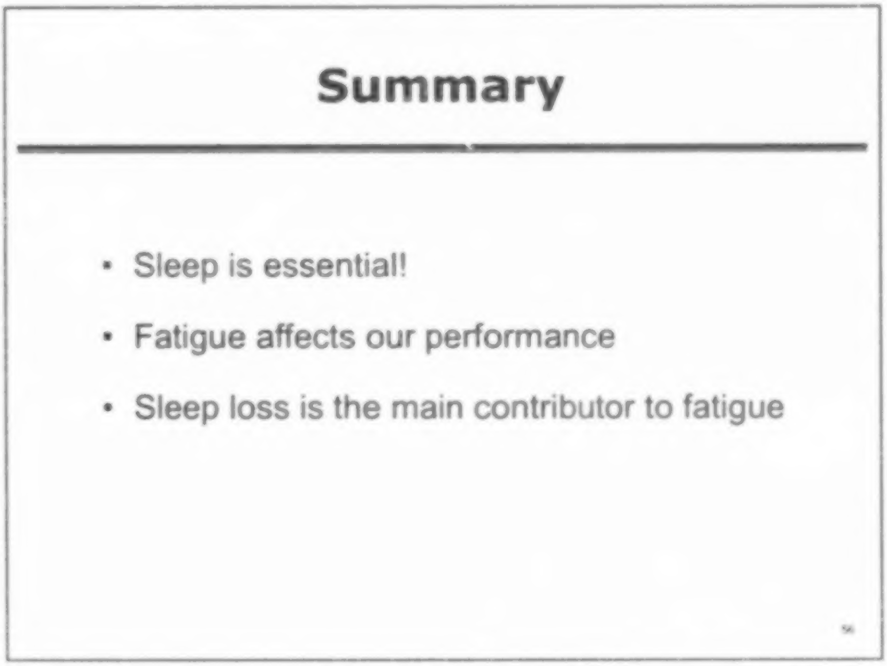


Effects of Caffeine and Alcohol on Sleep Structure



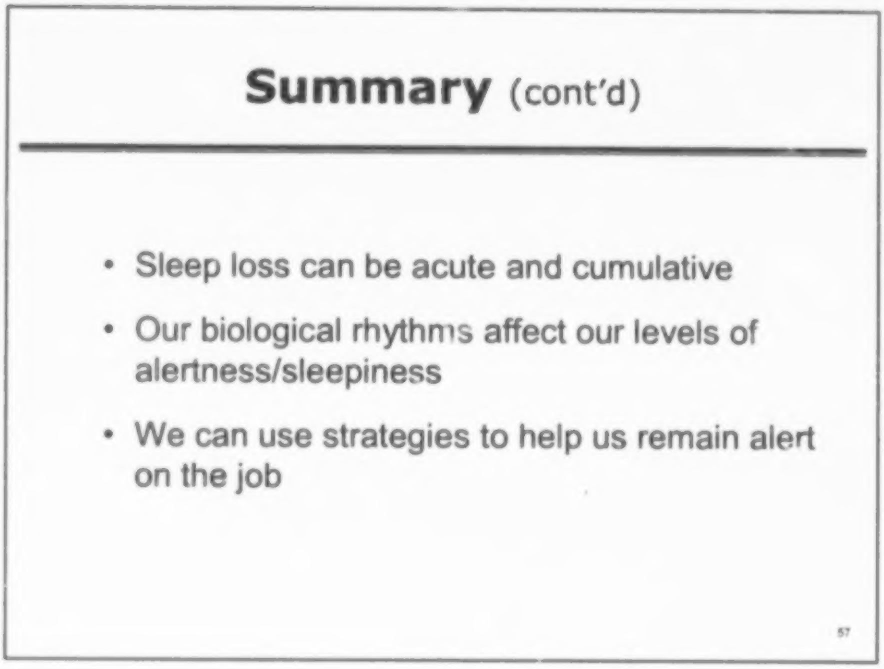
Other Strategies to Stay Awake

- Bright light
- Exercise
- Cool air
- Noise



Summary

- Sleep is essential!
- Fatigue affects our performance
- Sleep loss is the main contributor to fatigue



Summary (cont'd)

- Sleep loss can be acute and cumulative
- Our biological rhythms affect our levels of alertness/sleepiness
- We can use strategies to help us remain alert on the job